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THE AMERICAN NATURALIST

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DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE

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MAP OF NEW JERSEY.

Illustrating Dr. Hollick's paper.

THE

AMERICAN NATURALIST

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THE RELATION BETWEEN FORESTRY AND GEOLOGY IN NEW JERSEY.

ARTHUR HOLLICK.

I. Present Conditions.

The problems of plant distribution, or, in other words, the reasons why certain species, genera, or classes of plants occupy certain regions, have long received attention from those who have observed the facts. If the earth as a whole be viewed in connection with the entire vegetable kingdom, it is at once apparent that the most powerful factor in limiting the distribution of plants is climate, and that isothermal lines are closely identified with lines of plant limitation. If, however, smaller geographic areas and smaller aggregations of plants be considered, it will at once be seen that climatic conditions alone are not sufficient to account for all the facts of distribution and limitation which obtain, but that physiographic conditions, including altitude, presence or absence of moisture in the ground and atmosphere, surface configuration, etc., are among the factors which are the most influential. Finally, it may be noticed that there are some facts of distribution which are more or less independent of both climatic and physiographic condi-

tions. They appear to depend upon soil characteristics, either mechanical or chemical, and these characteristics constitute what may be termed the geologic factor, for the reason that the nature of the soil in any locality is directly dependent upon the nature of the geologic formation in that locality. It is with this phase of the subject that this paper is specially concerned.

It is unfortunate that by far the greater number of areal investigations which have been undertaken have been restricted by artificial boundaries, generally political, such as state or country lines, instead of having been extended to their natural limits, either physiographic or geologic, and many interesting problems, for this reason, have been only partially solved or outlined.

In New Jersey two distinctly defined forest zones have long been recognized,[1] *viz.*, a deciduous and a coniferous — the contrast between the two being so obvious as to attract the attention of even a superficial observer. On first sight the fact that the former zone is roughly confined to the northern part of the state, and the latter one to the southern part, might seem to indicate that the limits of the zones were determined by purely climatic conditions. If, however, the line of demarcation between them be followed across the state, or, better yet, beyond the confines of the state, it will at once be apparent that it does not coincide with any parallel of latitude or with any isothermal line, and also that it is not entirely dependent on topography or the physiographic conditions.

If, however, a geological map of the region be examined, the line of demarcation between the two zones will be seen to parallel very closely the general trend of the geologic formations, whose outcrops extend in a northeast and southwest direction across the state and southward beyond; and the inference is natural that this coincidence is not accidental, and that the reasons for it must be taken into account in studying the problem of the limitations of the zones.

[1] For a brief discussion of the subject, see Dr. N. L. Britton's Catalogue of Plants found in New Jersey, introductory chapter, *Final Report State Geologist*, vol. ii (1889), pt. i.

It was from this point of view that investigations were commenced, and as they proceeded it became more and more apparent that not only were the two great classes of angiosperms and gymnosperms strongly identified with certain geologic formations, but also that the distribution of many species within each of the zones was capable of being similarly identified, and their limits more or less accurately defined.

This line of investigation could, of course, be almost indefinitely extended, so as to include a much larger number of species, and if the entire flora of the state could be written up from the same standpoint, an exceedingly interesting contribution would result. If, further than this, the investigation could be made to cover a natural geologic area, instead of an artificial political one, the value of the work would be correspondingly enhanced.

The above-mentioned facts having been recognized by preliminary exploration, steps towards more detailed investigation were taken by traversing the state in a series of routes as nearly as possible at right angles to the trend of the geologic outcrops, thus crossing these in succession and noting whatever changes in the vegetation were apparent from place to place.

In pursuing the investigations in this manner the following facts were ascertained:

If an irregular line be drawn between Woodbridge and Trenton, and a similar one between Eatontown and Salem, the typical deciduous zone will be found to lie north of the former, and the typical coniferous zone south of the latter, while between the two is an area about sixteen miles wide, which may be termed the "tension zone," because it is there that the two floras meet and overlap, producing a constant state of strain or tension in the struggle for advantage.[1]

Within the limits of the deciduous and coniferous zones the conditions are more or less uniform; the typical or characteristic species in each have become firmly established in the environment most favorable to their growth, or unfavorable for others,

[1] An excellent general discussion of floral tensions may be found in Mr. Conway MacMillan's Metaspermæ of the Minnesota Valley, pp. 594–600, *Repts. Geol. and Nat. Hist. Sur., Minn.* Botanical Series I. 1892.

and the struggle for existence is largely between individuals of the same species. In the tension zone, however, the struggle is not only between individuals of the same species, but also between individuals and aggregations of different species. The elements in the deciduous flora are always ready to seize upon any advantage which will give them a foothold further south, while the elements in the coniferous flora are always ready for an opposite move. The former is a southward-moving, the latter a northward-moving flora. In consequence of these conditions, the area between their borders is in a state of unstable equilibrium, so far as its vegetation is concerned. The tension is constant, and any change in or interference with the environment releases the tension and causes a disturbance of the relations between the two floras until new conditions have become established. Each such disturbance is marked to a greater or less extent by changes of species, and lines of limitation thus vary from time to time.

The influence of civilization has been the most marked factor in this connection. Fire and cultivation have caused, directly and indirectly, great changes in the interrelations of species. In places certain species have been removed for economic purposes, and other species, less valuable, allowed to remain undisturbed; and this gives at once a direct advantage to the latter in the subsequent struggle for place. In other localities all species have been removed, and such a change wrought in the environment that foreign species, better able to adapt themselves to the new conditions, become established there.

Fire is probably the most destructive agency, as it not only destroys the living vegetation above ground, but often also the roots and seeds beneath. It is also to be borne in mind that in poor soil, such as obtains in the pine barrens, the ruin is more complete than in richer soil. In the latter case the soil will soon recuperate and be in a condition to start and nourish a new growth by reason of the diverse elements contained in it; but in the case of a sand or gravel soil, almost entirely composed of quartz, practically all the plant food is concentrated in the surface layer of humus, which has been slowly built up by the growth and decay of the vegetation itself, and when this is

destroyed the process of again enriching the soil is an exceedingly slow one. Fire-swept areas in the coniferous zone are, therefore, naturally barren for a much longer time than are similar areas in the deciduous zone. A corollary to the foregoing propositions is that changes wrought within the limits of the deciduous or coniferous zones would not normally lead to such extensive changes in species as would be the case under similar circumstances within the limits of the tension zone. In the former instances the original species would be likely to reappear again, as their relatives would be their nearest neighbors. In the latter instance, however, any change might afford just the advantage which some species of one of the border zones required for their establishment in new territory. It is in the tension zone, undoubtedly, that the greatest change in species and in the limits of species, has occurred, especially since the advent of civilization, as it is there that cultivation has been extended over the greatest area. In the marl belt the original forest was destroyed at a very early period, on account of the value of the soil for farming purposes, so that we do not know just what was the original condition throughout that region; but the indications are that coniferous trees were formerly more abundant than they are now, both in actual numbers and relatively to the deciduous trees; while in the bordering zones the relative proportions of the several species have probably always been about the same as now.

In the following table an attempt has been made to give an idea of the general character of the forests in the deciduous and coniferous zones by listing the species which were found to be the most conspicuous and characteristic in each.

Deciduous (Northern) Zone.

Gymnospermæ: *Pinus Strobus* L., *Tsuga Canadensis* (L.) Carr., *Juniperus Virginiana* L.

Angiospermæ: *Juglans nigra* L., *Hicoria ovata* (Mill.) Britton, *H. glabra* (Mill.) Britton, *H. alba* (L.) Britton, *Carpinus Caroliniana* Walt., *Betula lenta* L., *B. lutea* Michx. f., *Fagus atropunicea* (Marsh.) Sudw., *Castanea dentata* (Marsh.) Sudw., *Quercus Prinus* L., *Q. rubra* L., *Q. coccinea* Wang., *Q. velutina* Lam., *Q. alba* L., *Ulmus Americana* L., *Liriodendron tulipifera* L., *Platanus occidentalis* L., *Cornus florida* L., *Rhododendron*

maximum L., *Fraxinus Americana* L., *F. Pennsylvanica* Marsh., *F. lanceolata* Borck.

Scattering from the coniferous zone :

Gymnospermæ : *Chamæcyparis thyoides* (L.) B. S. P., *Pinus rigida* Mill.

Angiospermæ : *Diospyros Virginiana* L., *Ilex opaca* Ait.

Coniferous (Southern) Zone.

Gymnospermæ : *Pinus rigida* Mill., *P. echinata* Mill., *P. Virginiana* Mill., *Chamæcyparis thyoides* (L.) B. S. P.

Angiospermæ : *Quercus Phellos* L., *Q. nigra* L., *Q. minor* (Marsh.) Sarg., *Q. alba* L., *Q. coccinea* Wang., *Q. velutina* Wang., *Magnolia Virginiana* L., *Cratægus uniflora* Münch., *Prunus maritima* Wang., *Ilex opaca* Ait., *Diospyros Virginiana* L.

Scattering from the deciduous zone :

Gymnospermæ : *Pinus Strobus* L., *Tsuga Canadensis* (L.) Carr.

Angiospermæ : *Castanea dentata* (Marsh.) Sudw., *Hicoria alba* (L.) Britton, *Liriodendron tulipifera* L.

Species More or Less Abundant in Both Zones.

Populus tremuloides Michx., *Salix nigra* Marsh., *Betula nigra* L., *B. populifolia* Marsh., *Alnus rugosa* (Ehrh.) Koch., *Quercus ilicifolia* Wang., *Sassafras sassafras* (L.) Karst., *Liquidambar styraciflua* L., *Prunus serotina* Ehrh., *Acer rubrum* L., *Nyssa aquatica* L.

It may be noted that three species (*Q. alba, Q. coccinea,* and *Q. velutina*) are listed as characteristic trees in both zones. This means that they are so abundant in both that any description of the prevailing vegetation in either would be incomplete unless they were mentioned.

On the other hand, the species listed as abundant in both zones are equally wide in their distribution with the three species just mentioned, but none of them is so abundant as to be characteristic, being more or less scattered and usually following minor surface features, such as water courses swamps, roadsides, etc.

If a complete enumeration of the trees which inhabit each zone be studied, it may be readily seen that the deciduous zone contains the greatest number and diversity of genera and species, and that they are, as a rule, well mixed; no one species forming the bulk of the forest over any considerable area. In the coniferous zone, on the contrary, the monotonous uniformity

of the forests, due to extensive aggregations of a few predominant species, is conspicuous over hundreds of square miles. *Pinus rigida*, for example, is not only the predominant, but almost the exclusive species over extensive areas, but no such example can be quoted in regard to any one species in the deciduous zone. If the geology and topography of the zones be considered, it may be seen that the deciduous is exceedingly varied in each of these features. The geological formations represented are numerous ; the soil in consequence varies greatly, while the surface presents every gradation between low level plains and hills of considerable altitude. Its southern line is quite sharply coterminous with the southern edge of the Triassic formation, while in all other directions it extends up to and beyond the state lines. On the other hand, the coniferous zone presents but little diversity in either geology or topography. The geological formations represented are few. The soil has an almost uniform character throughout, and the surface irregularities are relatively small. Its northern border is coterminous with the northern border of the Tertiary gravels, sands, and sandy clays, and it is limited on its southern and eastern borders by a fringe of modern sand beaches and salt marshes, while southwestward it extends beyond the limits of the state. It is more restricted in area and less capable of expansion, by reason of its geographic position, than is the deciduous zone.

The tension zone includes practically the whole of the Cretaceous plastic clays and the Cretaceous and Tertiary clay-marls and marls. It is intermediate geographically, and in its geologic and topographic features, between the other two.

These facts may be observed to advantage at several critical localities, as, for example, in the vicinity of Farmingdale. At this locality there is an area of marl, like an oasis in a desert, located well within the border of the sands and gravels. If a line be traversed, starting from the vicinity of Lakewood, in the heart of the coniferous zone, little else than *Pinus rigida*, *P. echinata*, *Quercus alba*, *Q. velutina*, etc., are to be seen until the border of the marl area is reached, when the pines disappear and are replaced by deciduous trees, amongst which may be

noted *Quercus rubra*, *Hicoria alba*, *Ulmus Americana*, *Populus tremuloides*, *Castanea dentata*, *Liquidambar styraciflua*, *Betula nigra*, etc.; and these prevail until the marl area is crossed, and the sands and gravels are again encountered, when the conditions are reversed, pines once more become predominant; and this condition prevails until the main marl belt is reached near Eatontown, where deciduous trees again replace the pines. The lines of demarcation in crossing from one geological formation to the other are so sharply defined by the vegetation as to be apparent within a fraction of a mile.

If the same marl area be crossed in a direction at right angles to the previously described route, beginning in the deciduous zone near Monmouth Junction, an equally significant series of facts may be noted. In this vicinity the trees are almost wholly deciduous, consisting largely of *Quercus rubra*, *Q. alba*, *Q. velutina*, *Hicoria alba*, *H. glabra*, *H. ovata*, *Ulmus Americana*, *Fraxinus Americana*, *Fagus atropunicea*, *Castanea dentata*, *Liriodendron tulipifera*, *Liquidambar styraciflua*, *Populus tremuloides*, *Carpinus Caroliniana*, *Platanus occidentalis*, *Acer rubrum*, *Cornus florida*, etc., with occasional groups or individuals of *Juniperus Virginiana* and *Pinus Strobus*, all of large size or young vigorous growth.

In crossing the clay belt, towards Jamesburg, the first thing which attracts attention is that several of these species become less prominent, or disappear entirely, and that those which continue are noticeably smaller in size and less vigorous in growth. Several new species make their appearance, such as *Quercus ilicifolia*, *Q. nigra*, *Pinus Virginiana*, etc.; and these conditions prevail until well within the borders of the marl belt near Englishtown, when the trees again become somewhat larger in size. This variation in the size of the trees was found to be coincident in most cases with the presence or absence of local areas of sand and gravel — the smaller trees occurring in connection with these areas, which areas were also coincident with the distribution of certain species. For example, in one locality, about a mile north of Englishtown, the road passes through quite a deep cut, in a sand hill of considerable extent laterally and vertically. On this hill is quite a growth

of *Pinus rigida* and *Diospyros Virginiana*, although both species are conspicuous by their absence elsewhere in the vicinity.

In the neighborhood of Freehold some of the species which were sparsely represented before become more prominent, and then a marked change occurs as soon as the border of the main marl belt is passed. In place of the almost exclusively deciduous vegetation, patches of *Pinus rigida* become prominent; and these continue until the marl area at Farmingdale is reached, when the pines disappear and are not again met with until the area is crossed. By this route it may be seen that the entire width of the tension zone is crossed where the relations of the two floras are the most complicated.

Another interesting locality is the vicinity of Perth Amboy, where the terminal moraine extends beyond the Triassic border and encroaches for a short distance on the Cretaceous. Here the typical deciduous flora, which elsewhere is coterminous with the border of the Triassic, is in existence beyond, following the edge of the moraine, where it is in sharp contrast with the tension zone representatives of the coniferous flora, which here reach their most northern limit in the state.

At many other localities the same or similar facts may be noted, but the above instances are probably sufficient to illustrate the general facts of distribution.

In order to illustrate some facts of specific distribution, the following examples are taken:

Tsuga Canadensis. — More or less abundant in the deciduous zone, especially in hilly and rocky regions along the borders of streams. Not recorded south of the tension zone, except indefinitely as very rare, in Ocean and Monmouth Counties. The only exact localities known to me south of the Triassic border are New Egypt, Vincenttown, and Burlington, all within the tension zone.

Rhododendron maximum. — Abundant in the deciduous zone, often forming dense thickets along streams and lake borders. Recorded from but one locality south of the tension zone, at Sicklerville, and from two within the zone, at Burlington and Kinkora.

Pinus Virginiana. — More or less abundant in the coniferous zone, often forming small forests. Locally quite frequent in the tension zone, especially on the clay belt, but only recorded from within the deciduous zone, at widely separated localities — New Brunswick, Milford, and Riegelsville.

Pinus echinata. — Most abundant in the tension zone, often forming groves of considerable extent. Less abundant in the coniferous zone and not recorded from the deciduous zone.

Chamæcyparis thyoides. — Forms the bulk of the vegetation in the cedar swamps of the coniferous zone. Rare in the tension zone. Locally abundant in certain swamps in the deciduous zone.

Ilex opaca. — Common in wet woods in the coniferous zone. Less abundant in the tension zone. Reported from but one locality in the deciduous zone, at Carpentersville.

Quercus Phellos. — More or less abundant in the southern part of the state, especially in the tension zone, where it occurs close to the Triassic border, but has not been recorded from the deciduous zone.

Quercus nigra. — Practically the same range as the last.

That the distribution of these species is not wholly due to climatic conditions is evident. In the case of *Chamæcyparis* we have a species which occurs as far north as Massachusetts, and as far south as Florida, its occurrence being determined by physiographic conditions.

In considering others of the species we may even eliminate these conditions. *Quercus Phellos* and *Q. nigra*, for example, extend northward in the eastern part of the state as far as Perth Amboy, while in the western part they are not known north of Trenton. A line drawn between these two places defines the northern limit of distribution for these species. The topographic features in the immediate vicinity on both sides of this imaginary line are the same, and yet they do not cross it. The fact which is at once apparent, however, is that this line is coincident with the line of demarcation between the Triassic and Cretaceous formations, and the rational inference is that this feature is the important one to be studied. These two species are taken as special examples in this connection,

because their limits of distribution are so sharply defined; but careful tabulation of similar facts in regard to others would prove equally interesting and significant.

If the foregoing facts be carefully considered, one feature is sure to attract attention by reason of its constant reiteration. This is the influence apparently exerted by the geologic formations upon the distribution of certain classes and species of trees, or, for the sake of argument, the coincidence which exists between certain geologic formations and certain facts of plant distribution.

From whatever point of view we may regard the matter, it finally resolves itself into an examination of the soil conditions, which are directly dependent upon the structure and composition of the geologic formations from which the soils were derived. Soil influence is indicated in all the facts of plant distribution throughout the state as one of the most potent factors, and in some instances as the only one, to be taken into consideration; and here it seems pertinent to remark that the name which any geologic formation may bear is of no consequence in this connection, except for purposes of identification. The only matter of any moment is its lithological characters, either mechanical or chemical, irrespective of age or stratigraphic position. A sandy soil, whether a recent dune deposit or one formed from the disintegration of Paleozoic sandstone in place, would be of equal importance so far as sand-loving plants are concerned. In the same way a heavy soil, whether of cretaceous marl or glacial till, might be equally available as a home for species which must have such a mechanical condition for their proper growth. Those which merely require a rocky soil would also be indifferent as to whether the rock was Eozoic granite or Triassic trap.

This line of argument, therefore, infers that the mechanical structure of the soil is of equal importance with its chemical constitution; and this is apparently the fact. The observations made seem to indicate that the former is the more powerful in influencing the original location and distribution of species, while the latter more largely affects their subsequent growth.

Upon this basis of reasoning we may account for the fact that

species from the deciduous zone, where the soils are comparatively heavy, are able to push their way southward into the marl of the tension zone, and we may also note the effect of the chemical composition of the soil on the growth of these species, as indicated by their decreased size wherever they occur on areas of sand or gravel. In similar manner we can understand the reason for the northward extension of *Pinus Virginiana* at Perth Amboy, on account of the sandy or gravelly surface soil, and its abrupt limitation in that locality, at the terminal moraine, the soil of which is more compact and heavy. *Quercus Phellos* and *Q. nigra* are, without doubt, limited in their distribution by the same causes, and we are justified in assuming that if the soil conditions which favor them, or, what is the equivalent, the geological formation on which they grow, had a further northward extension, the species mentioned would be found upon it irrespective of climatic conditions.[1]

One thing, however, which should not be ignored in regard to characteristic species of any zone is that they do not always exist where they are found by reason of the environment being the most favorable one for them, but because the environment may be unfavorable for other species. For example, *Pinus rigida*, as previously noted, exists in parts of the sand barrens of Burlington, Ocean and Atlantic Counties, almost to the exclusion of all other trees; but it is stunted and conspicuously less vigorous in appearance as a whole than where it occurs as scattering groves or individuals further north in richer soil. The natural inference is that it would exist to better advantage in a different soil from that in which it is most abundant, but that other more aggressive species are able to occupy and hold such soils against it, and that in the sand barrens it merely exists by reason of freedom from competition. This inference is further strengthened if we consider its wide geographic range, which extends from New Brunswick to Georgia and

[1] The following references may be found of interest in this connection:

1. Britton, N. L. On the Existence of a Peculiar Flora on the Kittatinny Mountains of Northwestern New Jersey, *Bull. Torrey Bot. Club*, vol. xi (1884), p. 126.

2. Hollick, Arthur. Plant Distribution as a Factor in the Interpretation of Geological Phenomena, etc., *Trans. N. Y. Acad. Sci.*, vol. xii (1893), p. 189.

includes a great diversity of soil and climate. It is doubtful whether the sand barrens in many localities could ever be reforested by deciduous trees after the complete destruction of the pines. Certainly many such areas have remained completely devoid of any growth for many years, whereas in the deciduous zone clearings quickly become reforested, often by pines and cedars which were not before to be found in the region.

When the soil characters of each zone are studied, it becomes easy to understand why the character of the vegetation in each is so different. In the deciduous zone the rocks are partially weathered and disintegrated for a considerable depth, and this disintegration is unceasingly going on, constantly adding new material to the soil from the variety of the mineral constituents in the rocks. New soil is constantly being made and the old soil being renovated, so that plant food is in process of manufacture all the time. The character is also such that it is capable of retaining moisture for a considerable period, which is a valuable factor in periods of drought.

On the other hand, in the coniferous zone the rock has long been almost completely disintegrated, and as it is practically composed of but one constituent, quartz, which is of little or no value for plant food, any further disintegration is incapable of yielding any other element, and but little is added to the soil which could serve to support vegetation. Further than this, in many places no rock disintegration is going on, but, on the contrary, rock is in actual process of formation. Sandstones and conglomerates are being formed by cementation with limonite, and where this occurs, a hard layer results which limits the downward growth of roots, while if the conditions are such that an open porous sandy soil prevails, it becomes impossible for water to be retained in it, and an arid sand barren is the result.

The logical conclusion is that if the flora of the coniferous zone should be destroyed, its reëstablishment in the zone would be a very difficult matter on account of the hostile physical conditions which are ceaselessly at work there ; while in the deciduous zone its struggle for existence, even if it gained a

foothold there, could not be maintained against the more aggressive deciduous flora. That these adverse conditions, physical and biological, have long been active in modifying the character of the coniferous flora, and circumscribing its limits, we know from the geological records, and that they may be expected to continue in the future we have every reason to believe. In other words, we have to regard the coniferous flora, taken as a whole, as representing a waning type of vegetation, which reached its maximum of development in past geologic time, and which has since then been slowly but inevitably giving way to the deciduous type, which is now in the ascendant.

The relation between the historical development or evolution of the living floras and the facts of their present distribution will be discussed in a subsequent paper.

GEORGE BAUR'S LIFE AND WRITINGS.

WILLIAM MORTON WHEELER.

Georg Hermann Carl Ludwig Baur was born in Weisswasser, Bohemia, Jan. 4, 1859, into a family noted for its learning. His father and three of his father's brothers were professors in German universities. Among the latter was the theologian Gustav Baur, professor at Leipzig. George Baur's father, Franz v. Baur, was professor of forestry and director of the "Forstwissenschaftliche Versuchsanstalt" at Munich from 1878 to 1897, and rector of the university from 1895 to 1896.

George Baur.

The year after George Baur's birth Franz Baur, who had been chief forester ("Oberförster") of Weisswasser, left Bohemia and after a short stay in Giessen occupied a lonely "Forsthaus" between Frankfurt and Darmstadt. George Baur's earliest memories went back to this secluded dwelling in the forest of which his father was superintending forester. Here, too, the family did not tarry. In 1864 Prof. Franz Baur accepted the chair of forestry in the Academy of Hohenheim, near Stuttgart. Here he remained till he was called to Munich in 1878. It was in Hohenheim that George Baur passed the happiest years of his childhood. He was sent to school in the spring of 1865. According to his own statement, he learned with difficulty.

Memorizing, especially, was irksome to him, and in later years he often complained of the absurd pedagogical methods in vogue during his boyhood. Such time as he could spare from his lessons he passed in the woods about Hohenheim, and he has left a charming little description of himself and playmates acting Fenimore Cooper's *Mohicans*, chasing one another through the woods with bows and tomahawks. There was only a "Lateinschule" in Hohenheim, so George Baur's parents decided to send him to a "Realgymnasium" at Stuttgart. He accordingly left Hohenheim and entered on his further studies during Easter, 1873. The "Realgymnasium" had an excellent director, Dr. Dillmann, a man of whom Dr. Baur always spoke with gratitude and affection. The final examinations in the Stuttgart "Gymnasium" appear to have been very severe, for Dr. Baur has often told me that the horror of these examinations kept recurring to him in his dreams years after he had grown to manhood. These dreadful examinations, however, were successfully passed, and he left the last class of the "Gymnasium" during the autumn of 1877. During the year following he returned to Hohenheim and entered the academy with the intention of becoming a forester like his father. He became Professor Niess's assistant in geology and paleontology and soon decided to change his plans and make these subjects his life's work. In the fall of 1878 he entered the University of Munich. There he studied chemistry with Bäyer, zoology with v. Siebold, and botany with Nägeli, till he had completed the summer semester of 1880. Thereupon he went to Leipzig, and during the winter of 1880–81 and the following summer semester studied comparative anatomy with Leuckart, geology with Credner, and phylogenetics with Carus. During the autumn of 1881 he again returned to Munich to complete his university work. He studied paleontology with v. Zittel, physiology with Voit, and histology and embryology with v. Kupffer. He defended his inaugural dissertation, entitled "The Tarsus of Birds and Dinosauria, a morphological study," July 18, 1882. The *quaestio inauguralis* referred to Gegenbaur's archipterygium theory. Baur had now fully decided to follow a university career, and as the first step in this direction he became assistant in his-

tology to Professor v. Kupffer in the "Anatomisches Institut" of his alma mater. In March, 1884, he was called to New Haven to act as Professor Marsh's assistant. During the same year he married Fräulein Auguste Wachter of Munich. Dr. Baur served Professor Marsh till Feb. 1, 1890, when, owing to certain difficulties with that gentleman, he resigned his position and left Yale University. During the summer of 1890 he collected fossil reptiles and fishes in western Kansas for Professor v. Zittel. In the autumn he accepted the position of docent of comparative osteology and paleontology at Clark University, Worcester, Mass. The calm atmosphere of investigation pervading that institution allayed the excitement into which he had worked himself on leaving Yale, and having entered on a position where free and independent investigation and publication were not merely tolerated but required, he began to plan several extensive works. One of these was an elaborate monograph of the North American tortoises, to be published by the National Museum as a companion volume to Cope's *Batrachia*. Another was the investigation of the faunas and floras of oceanic islands. During the two years that Dr. Baur held his position at Clark he made great progress in both of these undertakings. In 1891, through the kindness of Mr. Salisbury of Worcester, Professor H. F. Osborn, and others interested in Clark University, he was enabled to fit out an expedition to the Galapagos Islands. Accompanied by Mr. C. F. Adams, he left in May and returned in October, after visiting nearly all the islands of the archipelago. The study of his extensive collections of the plants and animals of these islands has since occupied Dr. Baur and several zoologists and botanists both in this country and in Europe. The various reports, embodying descriptions of many new species, had been nearly all published, and just before his last illness Dr. Baur was planning a general work on the Galapagos Islands to include all the results of the expedition, together with an elaborate introductory chapter by himself. The valuable collections were recently purchased by the Tring Museum, which is undertaking a further study of the Galapagos fauna.

In 1892 Dr. Baur was called to the University of Chicago as assistant professor of comparative osteology and paleontology, and three years later was advanced to an associate professorship in the same institution. Here he bent all his energies to developing the department of which he had charge. For the purpose of increasing the paleontological collections of the university two expeditions were sent out, one to eastern Wyoming, in charge of Dr. Baur himself, and a few years later another to Texas, in charge of Dr. E. C. Case. Besides the work on the material collected on these expeditions, his turtle monograph, and the Galapagos material, Dr. Baur spent much time in working out elaborate courses of lectures on vertebrate osteology and phylogenetics. His classes were never large, owing partly to the advanced and highly specialized nature of the subjects presented and partly to his inability to express himself in a clear and attractive manner in the English language. Incessant work along so many different lines wore on his highly nervous organization. During September, 1897, his friends feared that his mental health was giving way, and he was persuaded to go abroad, in the hope that a year's sojourn with his relatives in Munich and southern Tyrol might restore him to health. His illness (general paresis) was not dispelled by the change. It was found necessary to transfer him to an asylum, where he soon succumbed, June 25, 1898. He was buried at Munich. Prof. v. Kupffer, who helped to equip the young scientist for his brief but brilliant career, placed the merited laurel wreath upon the grave. Very near Dr. Baur reposes George Ebers, who died a month later.

Such was Dr. Baur's external and uneventful life; his true inner life was one of constant and enthusiastic investigation, which is but imperfectly indicated in the list of his published works appended to this article. The hundred and forty odd papers bequeathed to science are only a prodromus of the greater things which he hoped to accomplish in the near future. Like Professor Cope, whom he greatly admired and whose successor in herpetology he had hopes of becoming, he possessed a very active mind and wide interests. That he was always busy with a number of problems simultaneously is shown by a perusal of

the list of his writings. None of his works are of considerable length, many of them are mere notices, but prolixity is not one of their faults. He often condensed much patient research, both in the laboratory and the library, into an astonishingly small space. He cannot always be excused from the fault of publishing too hastily and having subsequently to change his opinions. Nor did he always succeed in maintaining his ground against his opponents without undue emphasis and unpleasantness of expression. This unpleasantness of expression was unintentional, however; being due to a certain abruptness in the use of the English language. Most of his papers appeared in a comparatively small number of journals, many of them in the *American Naturalist* and the *Zoologischer Anzeiger.*

Dr. Baur's inaugural dissertation on the tarsus of birds and Dinosaurs is the keynote to much of his later work. It begins with a study of the developing limb skeleton of the bird and branches out into a comparative study of the limbs of the extinct Dinosaurs. The closing paragraph of the paper seems to contain the germ of his later views on the origin of variation, views which were practically identical with those of the Neo-Lamarckian school. In this paragraph he maintains that the appendages of oviparous animals are more variable than those of ovo-viviparous and viviparous forms, "as a viviparous animal which develops in the uterus, far from disturbing external influences, especially those of a mechanical nature, when born exhibits a tolerably truthful picture of its ancestors, since what it possesses at birth is inherited. An oviparous animal, on the other hand, will present a much less truthful picture of its ancestry," etc. Dr. Baur would probably have dissented from this crude view in after years, but he never altogether abandoned the assumption that variations in living organisms are traceable to the inherited effects of the environment.

Dr. Baur made the Reptilia the center of his researches in paleontology and osteology. His thorough and extensive knowledge of the diversified structure of living and fossil reptiles enabled him to arrive at very correct conclusions respecting mooted questions in the osteology of the fishes on the one hand, and the birds and mammals on the other. Dr. O. P. Hay, who

studied with Dr. Baur, has published in *Science* (July, 1898, pp. 69 and 70) a brief but excellent account of Dr. Baur's work in herpetology :

"Dr. Baur's especial interest was in the morphology of the vertebrate skeleton. Although he recognized the great value of descriptive osteology, such work alone did not satisfy the demands of his mind. Although he wrote much on vertebrate paleontology, he was the describer of few new genera and species. His constant effort was to discover the relationships of forms and the way in which they had originated. He was thus impelled to study the homologies of the various bones and to attempt to connect them with the skeletons of more primitive forms. In many of his papers we find attempts made to unravel the genealogy of groups and to base classifications on this genealogy. His views regarding the scope and the methods of comparative osteology may be learned from a lecture published in *Science*, 1890, vol. xiv, p. 281." * * * "In studying the development of the limbs, Dr. Baur held that the Amniota which possessed more than five fingers were highly specialized forms and not primitive ones, presenting transitions from the fishes. His view is now probably very generally accepted.

"A number of his papers related to the structure and the systematic position of the leather-back turtle Dermochelys. He opposed strongly the views of Cope, Dollo, Boulenger, and Lydekker, that this reptile forms a suborder distinct from all other living tortoises. He regarded it as belonging to merely a highly specialized branch of the Pinnata, a group which contains our living sea turtles.

"The structure and relationships of the Mosasauridæ form the subject of several interesting papers. In opposition to Professor Cope, who maintained that these extinct reptiles bore special relationship to the snakes, Dr. Baur held that they were true lizards, closely related to the Varanidæ, but modified for adaptation to an aquatic existence. An excellent paper on the structure of the skull of the Mosasauridæ was published in the *Journal of Morphology* for 1892.

"As early as 1886 Dr. Baur wrote a paper on the homologies of the bones of the otic and temporal regions. His interest in

the subject never relaxed, and some of his latest papers were written in a discussion of the subject with Professor Cope.

"In the same year above mentioned, 1886, Dr. Baur became interested in the morphology of the vertebral column, and he published a paper of considerable length in the *Biologisches Centralblatt* of that year, stating his conclusions. He gave his adherence to the opinion of Cope, who held that the vertebral centrum in all the Amniota has developed from the pleurocentrum, an element which is found distinct in the Stegocephali. He found confirmation of his views in the vertebral axis of the Pelycosaurian reptiles, in Sphenodon, certain lizards, birds, and even mammals. He advocated the same views in one of his latest papers.

"In the *American Naturalist* for May, 1891, occurs an important paper by Dr. Baur on the reptiles known as the Dinosauria. In a characteristic manner he gives the history and the literature of the subject and his own conclusions. His opinion was that 'the Dinosauria do not exist.' He believed that this group is an unnatural one, and is made up of three special groups of archosaurian reptiles which have no close relation to one another.

"Two of Dr. Baur's most important later efforts are probably one entitled 'The Stegocephali,' a phylogenetic study published in the *Anatomischer Anzeiger* for March, 1896, and one, a joint paper with Dr. E. C. Case, having the title 'On the Morphology of the Skull of the Pelycosauria and the Origin of the Mammalia,' and appearing in the *Anatomischer Anzeiger*, 1897, pp. 109–20. In the first-mentioned paper Dr. Baur compares the skeletal structure of the Stegocephali with that of various fishes, and comes to the conclusion that the Batrachia took their origin from the Crossopterygia, rather than from the Dipnoi. The second paper was based on the fine materials collected by Dr. Case in the Permian formation in Texas. The authors concluded, on the one hand, that the Pelycosauria are closely related to the Rhynchocephalia, and that, on the other hand, they could not have been the ancestors of mammals. The authors were inclined to regard the Gomphodontia as the ancestors of the mammals."

Dr. Baur's interest in the more general problems of morphology, such as the origin of variations, was first keenly aroused at Clark University at a time when Weismann's essays were the subjects of much general discussion. He always remained a steadfast Neo-Lamarckian, never forsaking the position he had taken in his inaugural dissertation. A perusal of Wagner's and Eimer's works convinced him that isolation and environment are potent factors in producing variation. A previous study of the giant land tortoises of the Galapagos, in connection with his turtle monograph, and further studies on a genus of lizards (Tropidurus) which has produced different so-called species on the various islands of the archipelago, led him to conclusions which his subsequent visit to the islands did not modify. It was, perhaps, fitting that one born in the year of the publication of the *Origin of Species* should gain inspiration from the spot where the idea of the "Origin" was conceived. At the very outset, however, he announced a far-reaching opinion utterly at variance with Darwin's view of the origin of the Galapagos. The great English scientist believed that the Galapagos were oceanic islands that had never been connected with the mainland — a view which Alex. Agassiz has supported after renewed study of the region. Dr. Baur rejected the hypothesis of the consistency of continents and oceans and asserted that the Galapagos, like the Antilles, were formed by subsidence and not by upheaval, and that they were at one time connected with Central America through Cocos Island. This contention Dr. Baur attempted to prove by showing that each separate island has its own peculiar and harmonious fauna and flora — a condition which could hardly exist if the archipelago were of volcanic origin and had acquired its plants and animals through accidental importation by means of currents from the mainland. Dr. Baur insisted on the harmonious distribution over the various Galapagos Islands of such organisms as the giant land tortoises, the lizards of the genus Tropidurus, the species of Nesomimus and other passerine birds, and the plant known as *Euphorbia viminea*. Since there was no evidence of intermigrations between the various islands to disturb the pronounced individual character of their faunas and floras, how

could one suppose that the islands had been originally peopled from the mainland six hundred miles away? Surely, he contended, isolation of faunas and floras, produced by the gradual subsidence of a mountainous area and its conversion into islands, would be a far simpler and more adequate explanation of the facts than the Darwinian theory of upheaval. Dr. Baur's view met with derision in some quarters, but recently investigators of repute, like Günther, Ratzel, Böttger, Ortmann, and Hemsley, have cast their vote in his favor against Darwin, Wallace, A. Agassiz, Stearns, Dall, and Wolf. Ridgway, who has studied the birds, and Robinson and Greenman, who have studied the Galapagos plants collected by Dr. Baur, have taken a safe neutral ground and await further evidence before expressing an opinion.

Encouraged by the recognition of the subsidence theory, Dr. Baur began to test the faunas and floras of other islands in the Pacific in the same manner as he had tested those of the Galapagos. In his last paper in the *American Naturalist* he took up the distribution of various groups of animals (crustaceans, ants, frogs, lizards, and birds) on the Solomon and Fiji Islands, and in New Caledonia, in an endeavor to show that these islands, too, were of continental origin, contrary to prevailing opinion. He did not live to complete this paper, his last effort to break the bonds of authority and open to renewed discussion the question of the origin of island faunas and floras. The man to continue this work worthily has not yet risen among us.

A LIST OF DR. BAUR'S WRITINGS.

1. Der Tarsus der Vögel und Dinosaurier. Eine Morphologische Studie. Inaugural-dissertation. Univers. München. Leipzig, 1882, Wilh. Engelmann, pp. 1–44, 2 Taf. *Same* in *Morph. Jahrb.*, Bd. 8, 1883, pp. 417–456, Taf. XIX and XX.
2. Der Carpus der Paarhufer. Eine Morphogenetische Studie. (Vorl. Mittheil.) *Morph. Jahrb.*, Bd. 9, 1884, pp. 597–603.
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ON THE SPECIFIC GRAVITY OF SPIROSTOMUM, PARAMÆCIUM, AND THE TADPOLE IN RELATION TO THE PROBLEM OF GEOTAXIS.[1]

JULIA B. PLATT.

It is known that some algæ and Infusoria tend to collect near the surface of the water in which they live. A number of experiments have been made which seem to demonstrate that the tendency thus manifest cannot be ascribed altogether to the attraction of light, or to the source of oxygen supply, since these algæ and Infusoria still move upwards when the experimental conditions are such as destroy or reverse the normal relations to air and light. It is, therefore, affirmed that these organisms react to the force of gravity. This reaction, or negative geotaxis, is attributed by Schwarz ('**84**) to the direct influence of gravity on the organism, which incites motion in the opposed direction, while Jensen ('**93**) attributes the reaction to the indirect influence of gravity on the organism by means of the difference in hydrostatic pressure at different depths. The experiments of these authors seem to show that the possibly excentric position of the center of gravity in the organism cannot be regarded as a factor determining the direction of motion.

Dr. C. B. Davenport suggested that a simple and hitherto unrecorded method of approaching the problem of geotaxis might be by means of solutions of varying density in which the infusorian would still live. Obviously, if the conclusion of Schwarz ('**84**) were right, the negatively geotactic organism should become positively geotactic in solutions of greater specific gravity than its own, supposing the animal to be normally heavier than water.

[1] This short study was undertaken as laboratory work in connection with Dr. C. B. Davenport's course in *Experimental Morphology*. My cordial thanks are due Dr. Davenport for the kind interest with which he followed the work.

Unfortunately, for the success of the experiment, I have been unable to obtain in Cambridge, Paramæcia which showed decided geotactic reaction. My results may, nevertheless, serve as a basis for further experiment by those more fortunate in the material at their command.

The Method.

The specific gravity of the organism was to be obtained by finding the density of a solution in which the animal, either dead or paralyzed, remained suspended without rising or falling. This known, the movements of the living infusorian in solutions of the same, of greater, and of less specific gravity were to be recorded. It was, therefore, necessary to find a substance in solutions of which Infusoria will live, and a reagent that will kill or paralyze the animal with little apparent change of form.

I found that in solutions of salt, sugar, and glucose, of sufficient density to be serviceable, Infusoria do not live, but in dying increase their specific gravity, probably owing in great part to loss of water. Gelatine was not satisfactory, since even weak solutions tend to become stiff when cold. After failing with the above-mentioned substances, I found gum arabic admirably adapted to my purpose. Solutions surpassing the specific gravity of protoplasm are easily obtained, and Paramæcia or Spirostoma live for hours in solutions heavier than their specific gravity, not only surviving, but also multiplying, when kept for days or weeks in solutions of less weight.

To exclude the small error that might arise from water contained in the gum, the specific gravity of the solution has not been determined by adding a known weight of the gum to a given volume of water, but in each case the solution has been weighed and compared directly with the weight of the same volume of water.

Spirostomum.

Although Spirostoma frequently lie on the bottom of the vessel in which they are cultivated, they are also often found

suspended in the water with their long axis in a vertical plane, and with the anterior end of the body directed upwards. As it is possible that the maintenance of this position is in reaction to gravity, I tried the effect of placing Spirostoma in solutions denser than water. When Spirostomum moves, it usually advances first the smaller end of its elongated body, or the end which is opposite the large contractile vacuole; and this I consequently call the anterior end of the body. Spirostomum occasionally reverses its cilia and moves backwards, but the regression is of momentary duration, and the small organism returns directly to its usual manner of motion.

A fortunate accident by which a faint trace of some unknown poison must have been present in the culture jar to which a number of Spirostoma were transferred, rendered these Infusoria motionless without killing them. When examined under the microscope it was found that their cilia did not move, yet an occasional spasmodic contraction demonstrated that life still continued. I was thus enabled to obtain the weight of *living* Infusoria, and the result was subsequently confirmed by similar experiments with Spirostoma that were not poisoned, but merely exhausted by long cultivation in the laboratory.

To avoid currents that would arise from introducing water with the Spirostoma into the gum arabic solution, they were first drawn from the culture jar with a pipette and ejected into a watch glass, which was gently shaken so that the Spirostoma gathered at the bottom. The water that had been taken up with them was then withdrawn, and gum arabic of the same density as the solution to which they were about to be transferred was substituted. In this solution of gum arabic the Spirostoma were again drawn into a pipette and ejected gently into the midst of the solution with which their specific gravity was to be compared.

In determining the specific gravity of these Infusoria, the reaction during the first fifteen or twenty minutes is alone to be trusted, since Spirostoma, and also Paramæcia, whether living or dead, increase their specific gravity on remaining long in a solution of greater density than water. The paralyzed,

but still living Spirostoma were placed in solutions of differing densities with the following result:

In H_2O, every Spirostomum immediately fell to the bottom.

In gum arabic solutions of sp. grav. 1.0110, all of the Spirostoma fell to the bottom within fifteen minutes, except two or three that were still falling.

sp. grav. 1.0165, the Spirostoma were carried by the slight currents. For the first five minutes indifferently. They then slowly rose, but not to the surface, then fell, but not to the bottom. They were evidently nearly balanced.

" " 1.0165, the above experiment was repeated, and the Spirostoma remained scattered for twenty to thirty minutes. Then all drifted upwards except six which lay on the bottom.

" " 1.0180, Spirostoma remain still for a long time.

" " 1.0190, Spirostoma remain still for a short time, and then rise, *several coming to the surface.*

" " 1.0190, the above experiment was repeated with the same result.

" " 1.0208, Spirostoma slowly rise.

" " 1.0230, after ten minutes thirteen Spirostoma were floating on the surface, and but two still remained in the solution. Both of these were rising. When the solution was shaken, all were scattered, and then rose to the surface again. After two hours all fell to the bottom.

From these experiments it appears that the specific gravity of Spirostomum lies between 1.0165 and 1.0180, or very near to 1.017.

Jensen ('93) also attempted to obtain the specific gravity of an infusorian, Paramæcium, by finding the density of a solution in which the infusorian would neither rise nor fall. He chose for the experiment, however, potassium carbonate, which immediately kills the organism. By means of solutions of potassium carbonate, Jensen decided that the specific gravity of Paramæcium was 1.25. Since his conclusions differ so greatly from the results obtained with gum arabic and living Spirostoma, I repeated the experiment by placing Spirostoma in a solution of potassium carbonate of 1.25 specific gravity, and found that this infusorian rose at once to the surface, and then fell directly back into the solution, where it remained in fact suspended. Evidently potassium carbonate of this density rapidly reduces the protoplasm of the organism to its own weight. Only the

extent of the change (from 1.017 to 1.25) was surprising, for I had already found that Spirostomum changed its weight slightly when living in a medium denser than water, and had also found that, when killed with any one of several reagents, the specific gravity of Spirostomum increases. For example, when Spirostomum is killed with quinine, it sinks in solutions of gum arabic of 1.028 specific gravity, although the living but motionless Spirostomum quickly rises to the surface in a solution of this density.

On placing Spirostomum in a solution of gum arabic slightly denser than its own protoplasm, I found that the infusorian did not remain still in a vertical position, as is its habit in water, but wandered restlessly about. Of those individuals which at the time of observation occupied a vertical, or nearly vertical position, the number with the anterior extremity directed upwards was 48. The number of those with the anterior extremity directed downwards was 81. The larger number of individuals having their anterior extremity directed downwards suggests a tendency to reverse the normal position maintained in water, where the anterior extremity is directed upwards. I doubt, however, if the difference in the numbers should be thus interpreted; for if Spirostomum merely wandered back and forth between the upper and lower surfaces of the liquid, it would rise in a dense solution more rapidly than it would descend. There would thus be at any moment more individuals going downwards than upwards. The power of nice adjustment between the force of the cilia and the force of gravity, which maintains Spirostomum suspended in water, was lost in those individuals which I observed when placed in solutions of greater specific gravity than their own. My conclusions regarding their reaction to gravity are, therefore, purely negative.

Paramæcium.

To obtain the specific gravity of Paramæcia, I tried to paralyze them with ether, quinine, and nicotine, but invariably killed the Paramæcia, which in dying went to pieces. I therefore added a few drops of 0.5 per cent acetic acid to the water con-

taining the Infusoria. As acetic acid is said to swell protoplasm, I also killed Paramæcia by the fumes of osmic acid. Both these reagents caused the Paramæcia to change their shape somewhat in dying, by becoming wider and shorter. Their form, however, remained symmetrical in both cases, and seemed neither enlarged nor distorted.

The results obtained by the two methods were similar. When the killed Paramæcia were placed in a gum arabic solution of 1.018 specific gravity, they remained long suspended in the solution. In a solution of 1.024 specific gravity they rose to the surface as rapidly as they fell when placed in water. The reaction in solutions of nearly the same specific gravity as Paramæcium is less certain than with Spirostomum, since the smaller size of Paramæcium makes it more liable to drift up or down with chance currents, and less rapid in its response to gravity. There is, however, no doubt that the specific gravity of Paramæcium thus killed differs but little from that of living Spirostomum, and differs very greatly from the specific gravity assigned this infusorian by Jensen ('93).

The Paramæcia found in the cultures of our laboratory and in the water of the pools about Cambridge did not show geotactic tendencies. If one were placed in clear water, and were drawn into a capillary tube held vertical, it would rise to the upper surface of the water drawn into the tube, and if the tube were now directly reversed, the Paramæcium would rise again; but if the tube were retained in its original vertical position, the Paramæcium wandered back and forth between the upper and lower surfaces of the water. The water of the culture vessels, which contained dead leaves, bacteria, etc., soon swarmed throughout with Paramæcia, which were found in greatest quantities at the surface where a scum of bacteria gathered. If these superficial bacteria were placed in a glass of clear water, they wandered up and down indifferently.

Tadpoles.

Some toad tadpoles that had just left their gelatinous envelope were observed by Dr. Davenport to swim at once to the

surface of the water in which they were kept. He therefore suggested that the negative geotaxis they thus manifested should also be tested in solutions of gum arabic of differing densities.

I found that between the lengths of 9½ mm. and 12 mm., the specific gravity of the tadpoles decreased from 1.044 for the smaller, to 1.017 for the larger. The smaller tadpoles, which showed marked geotactic tendency, were placed in a phial filled to the brim with a solution of gum arabic heavier than the tadpoles, and the phial was then inverted with care that no bubbles of air were admitted. The tadpoles, which could not have been attracted upwards by the light, since light was admitted at all sides through the glass of the phial, immediately swam upwards, as they had done in water. As there was no air between the bottom of the inverted bottle and the upper surface of the solution, it was equally improbable that the tadpoles were attracted upwards by the air.

When placed in solutions of the same specific gravity as themselves, it was found that the tadpoles still swam to the upper surface of the solution, which as before was in immediate contact with the bottom of the inverted phial. From these experiments it appears that the attraction upwards is neither air nor light, and that the direct action of gravity as expressed in the weight of this organism does not act as the incentive to negative geotaxis. It is possible that gravity may act, however, on some internal organ which is unaffected by the change in the density of the surrounding medium, and may by this means induce the movement upwards. Loeb (**'91**) has shown that the semicircular canals of the ear in sharks act as balancing organs. Should this also be true for tadpoles, we might find here the explanation of their constant motion upwards, even when the direction of the action of gravity on the organism as a whole has been changed by placing the organism, normally heavier than water, in a medium of greater specific gravity than itself.

It is, moreover, by no means impossible that the action of gravity, which determines the direction in which the Infusoria move, may be through the internal organization of the animal.

In this case the density of the surrounding medium might be expected to effect little, if any, change in the direction in which the organism moves.

Results.

(1) The specific gravity of living Spirostomum lies between 1.016 and 1.018, or is near to 1.017.

(2) The specific gravity of Paramæcium killed by acetic acid, or by the fumes of osmic acid, differs little, if any, from the specific gravity of living Spirostomum, and is about 1.017.

(3) Small tadpoles that are negatively geotactic do not become positively geotactic when placed in solutions heavier than their own specific gravity, as one would expect were their upward motion in direct response to the action of gravity on the organism as a whole. These tadpoles show constant negative geotaxis in water, in a solution of their own specific gravity, and in heavier solutions.

RADCLIFFE COLLEGE, CAMBRIDGE,
June 11, 1896.

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VERNAL PHENOMENA IN THE ARID REGION.

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It has recently[1] been laid down by Dr. C. H. Merriam that "the northward distribution of terrestrial animals and plants is governed by the sum of the positive temperatures for the entire season of growth and reproduction," and that "the southward distribution is governed by the mean temperature of a brief period during the hottest part of the year." Dr. Merriam further explains that, "in computing the sum of the positive or effective temperatures, a minimum temperature of 6° C. (43° F.) has been assumed as marking the inception of the period of physiological activity in plants, and of reproductive activity in animals." Let us now consider the facts as observed at Mesilla Park, New Mexico (altitude 3800 feet), and then discuss their bearing on Dr. Merriam's theories. From the meteorological data collected by observers at the Mesilla Park Experiment Station, I have selected the following as illustrative:

	Mean Temperature (F.).		Maximum Temperature.		Minimum Temperature		Precipitation (Inches).	
	1893.	1896.	1893.	1896.	1893.	1896.	1893.	1896.
January	43.4	41.4	73	71	10	9	.07	.31
February	44.5	41.5	71	75	14	10	1.26	.11
March	50.6	50.5	87	89	21	15	.01	.00
April	58.5	52.3	91	87	29	23	.00	.11
May	62.6	67.0	93	101	33	31	.77	.10
June	77.3	76.8	105	104	46	46	.00	1.01

The following are the latest dates on which the thermometer fell to 30° F. during six years:

1893.	30° on April 29.	1896.	29° on April 20 (23° on April 17).
1894.	30° " " 2.	1897.	29° " " 10.
1895.	30° " " 3.	1898.	29° " " 4.

[1] Life Zones and Crop Zones of the United States, 1898, *National Geographic Magazine*, December, 1894.

The mean temperatures, even in January and February, are high enough to stimulate growth *in those plants which have been introduced from more humid regions*, but *the native vegetation remains backward, notwithstanding the warmth.* The introduced fruit trees at Mesilla Park, many of them, bloom early and have the flowers or fruit annually destroyed by frost. Mr. F. Garcia has kindly given me the following illustrative data:

Kelsey plum	blooms	March 5–11.	Bidswell Late peach	blooms	March 5–7.
Huanhume plum	"	Feb. 19, 20.	Peento peach	"	March 5, 6.
Bungoune apricot	"	Feb. 19, 20.	Foster peach	"	March 16–22.
Moorpark apricot	"	March 8–10.	Elberta peach	"	March 17–22.

The two last-mentioned peaches do not always fail.

There is one native flower which is earlier than any of the above fruit trees, namely, *Sophia halictorum* Ckll. I have found this in bloom as early as January 31, and it is not injured by the subsequent frosts.

This year (1898) Miss Ivah R. Mead made some studies of the life of the tornillo or Pluchea zone at Mesilla Park, which she submitted as a thesis for the degree of B. S. at the New Mexico Agricultural College. The following observations were made by her on a small selected area of the zone in question:

March 12. Everything seemed dead, all that I could find being two tiny plants less than 3 cm. high. These plants were sprouts growing from perennial roots.

March 29. Ten species of plants were found growing; six were too small for identification; the greatest heights of any of the others were:

Pluchea borealis	10 cm.
Gutierrezia sarothræ . . .	15 cm.
Sophia halictorum	9.5 cm. (just beginning to flower).
Sphæralcea lobata	11 cm.

All were perennials or biennials, except the *Sophia*. The cottonwood trees (*Populus fremonti*) were in bud. The mesquite (*Prosopis glandulosa*) and tornillo (*P. pubescens*) showed no signs of life.

April 5. Grass getting quite green. The grass in protected places under the tornillo bushes is doing much better than in the open places.

April 12. Two cottonwood trees in flower. The tornillo bushes still show no sign of life. *Sophia halictorum* is ripening its seeds.

April 23. Tornillo still dormant. *Lycium torreyi* is quite green. A bush of *Atriplex canescens* in full leaf.

April 25. Mesquite bushes show the first tiny green leaves, but tornillo still dormant. *Lycium torreyi* shows the first blossoms.

April 28. One tornillo bush showed signs of life.

By May 11 the mesquite was in full leaf, as also the cottonwood. *Lycium torreyi* was in fruit, but the berries were still green. By May 18 all the tornillo bushes were in full foliage, and the mesquites were flowering.

Miss Mead's notes are considerably more detailed than the above extracts, but it hardly seems necessary to quote them in full. Speaking generally, the facts are these: With one or two exceptions, the native vegetation is backward, notwithstanding the warm weather; *but after the period of the latest killing frosts it comes out with remarkable rapidity*, and a couple of weeks mark the change from barrenness to verdure. At Mesilla Park the domestic honeybee is abroad more or less even in January, but the native bees behave like the native vegetation. That is to say, they do not appear at all until late in March; but then come on very *rapidly*, so as to be very numerous in species and individuals early in April. In 1894 the first bees in this vicinity were taken on March 26, at Little Mountain; but this is above the cultivated area and is warmer than it, the cold air settling in the bottom land. On April 9, however, bees were abundant at the plum blossoms at Mesilla Park, the genera Osmia, Nomada, Synhalonia, Podalirius, Anthidium, Andrena, Prosapis, Halictus, and Agapostemon being represented. At the beginning of May the willows were in flower and attracted various bees.

In 1896 I took two specimens of *Halictus pruinosus* Rob., at Mesilla Park, as early as March 18, and this is my earliest date for a wild bee in that locality. By way of contrast with the above, we may now consider the state of affairs in Washington State. The following meteorological data have been kindly furnished by Mr. G. N. Salisbury, of the Weather Bureau, at the request of Mr. T. Kincaid:

(1) Average temperature (F.):

	Tatoosh Island (Cape Flattery).	Seattle.	Kennewick.
January	41.7	40.6	23.2
February	41.8	41.0	34.2
March	45.8	44.6	51.3
April	47.2	48.5	54.5
May	51.7	55.0	64.3
June	54.3	59.9	70.0

(2) Average precipitation (inches):

	Tatoosh Island.	Seattle.	Kennewick.
January	12.73	4.80	1.54
February	8.50	3.41	0.42
March	9.14	3.42	0.30
April	7.36	4.01	0.39
May	4.58	2.65	0.50
June	4.04	1.35	0.49

Tatoosh Island has 233 cloudy days in the year, Seattle 159, and Kennewick 58. Of these localities, the first two belong to the excessively humid coast belt; the third is east of the coast range and partakes more of the characters of the arid region. It will be seen at once that the moist region has a comparatively warm winter but a cool summer; the difference between the mean temperatures of January and June being from 13° to 20° F. The inland region, on the other hand, has a colder winter climate, and a considerably hotter summer, with nearly 50° difference between January and June. Comparing the average temperatures at Mesilla Park with these, we find that the first two months nearly agree with those at Seattle, the last four much more nearly with those at Kennewick.

Yet the season at Seattle is ahead of that at Mesilla Park, so far as flowers and wild bees are concerned. Mr. T. Kincaid wrote me from thence on March 13, 1898:

"The willows are now blooming, as well as several other plants, such as *Rubus spectabilis*, *Nuttallia cerasiformis*, *Ribes sanguineum*, etc. Only a few species of bees have appeared so far."

Mr. Kincaid sent me a series of *Andrena perarmata* Ckll., taken at Seattle on March 15 and 16; while Mr. Dunning (*Canad. Entom.*, 1898, p. 269) reports Seattle specimens of this species taken from February 16 to March 14. Many other facts of this kind will doubtless be published by Mr. Kincaid, who is studying the bees of his region.

I do not know when the bees first fly at Kennewick, but it is probably later than at Seattle, for the same reasons that affect the Mesilla Valley.

So much for the facts; how do they affect the theory set forth at the beginning?

It appears to me that throughout the arid region, where the sky is clear and the radiation great, *the development of plants and insects is controlled largely by the distribution of frosts throughout the year.* By a process of natural selection the native species (except such as are frost-proof) have learned not to appear or develop until the danger of frost is over. That this tardiness is not due to lack of warmth *per se*, is shown by the fact that introduced plants, such as the fruit trees, rush into bloom and get nipped in consequence. In the cloudy Seattle region it is very different. The climate is more uniform, and there is much less danger of frosts following warm weather. Consequently, both bees and flowers appear early.

The climate of the arid region is thus peculiar and presents a barrier to the ingress of plants and animals from without. For tropical and subtropical species the winters are too cold; for species of moist temperate regions the late frosts following warm spells are usually destructive. It is a curious anomaly that, in a locality having more than tropical summer temperatures, fruits of the temperate zone should fail on account of frost!

Fortunately for the horticulturist, we already know many good late varieties of fruit trees, which escape even the latest frosts at Mesilla Park. But there can be no doubt that the true path to success will be that of selection, and the origination of new and specially adapted varieties; that is to say, man will have to imitate, in as short a while as he can, the process of nature in the case of the native productions. When he has accomplished this, he will reap the full benefit of the many excellent qualities of the climate, the dryness, sunshine and warmth, with moisture under control through a system of irrigation.

A REVIEW AND CRITICISM OF SEITARO GOTO'S[1] WORK ON THE DEVELOPMENT OF ASTERIAS PALLIDA.

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The study of echinoderm development has till recently remained in what may be described as a tantalizing condition. The course of the ontogeny in its main outlines has been known since the days of Johannes Müller, whose work, together with that of Professor Agassiz ('64), may be said to have given us a sketch the details of which had to be filled in. Leaving out of sight the crinoids, which are separated by a deep anatomical gulf from the other echinoderms, we had the researches of Ludwig ('82) on the development of *Asterina gibbosa*, followed by those of Semon on *Synapta digitata* (7), of Bury ('89, '95) on the pelagic larvæ generally, and of Théel ('94) on the development of *Echinocyamus pusillus*, to mention only the most important contributions to our knowledge of the subject. The general disappointing feature about the situation was that whilst there were plenty of half-worked-out problems presented, and suggestive new facts brought to light, there was an absence of any attempt to thoroughly and exhaustively examine the development of any one form, so that instead of certainties we had surmises as to the meaning and fate of larval structures.

This want I endeavored to meet some years ago by a study of the development of *Asterina gibbosa* ('96) from the blastula to the young starfish with ovaries already developed, using the most refined methods, and having at my disposal an immense amount of material. The larva of *Asterina gibbosa* is, however,

[1] Goto, Seitaro. The Metamorphosis of *Asterias pallida*, with special reference to the fate of the body cavities, *Journal of the College of Science*, vol. v. Imperial University, Tokio.

as all know, a modified one, and it was, therefore, my earnest desire that the results obtained by the examination of this form should be tested by a comparison with the development of a normal pelagic larva. And it was, therefore, with considerable pleasure that I awaited the publication of Dr. Goto's researches.

Speaking broadly, a remarkable similarity is disclosed between the two types of development. Some of Goto's figures are almost identical with those which I have already published. I shall first, therefore, sketch the general scope of the paper, and then discuss the principal points of difference between Dr. Goto and myself.

The paper commences with a description of a young bipinnaria, practically quite bilaterally symmetrical, lettered by Goto as stage *B*, the stages considered in the paper being denoted *B, C, D, E, F, G, H*. [I assume, although Dr. Goto does not say so, that the lettering has been chosen to correspond as far as possible with the lettering of the stages of *Asterina gibbosa* given by me; stages *E, F, G*, and *H* appear to be identical in the two cases, and unless this were so, I utterly fail to grasp why Dr. Goto calls the first stage *B*. It is to be desired that this should be explicitly stated, since it is undesirable to introduce an independent lettering with every new species examined.] The changes in external form are then carefully explained; the plane of the developing disk of the starfish is at first parallel to the sagittal plane of the larva; but as development proceeds it is shifted backwards until it occupies the posterior pole of the larva, and is then perpendicular to both the sagittal and frontal planes — so that the direction right to left in the larva is parallel to the disk, as well as the direction dorsal to ventral.

As development proceeds, three "brachiolar" arms are developed on the præoral lobe surrounding a thickened patch of ectoderm, and so the bipinnaria becomes a brachiolaria. Dr. Goto was unable to observe any fixation during the metamorphosis, such as has been seen by Bury ('95) in the case of *Asterias rubens*, and by myself in *Asterina gibbosa* ('96).

As in the case of *Asterina gibbosa*, and contrary to what was believed to take place in the case of bipinnaria, both the larval œsophagus and the larval rectum atrophy; — the præoral lobe

gradually shrinks, and thus the metamorphosis is complete. It is interesting to note that, according to Goto, the permanent œsophagus is fashioned out of the endodermal stump of the larval one.

The fate of the cœlomic cavities next claims Dr. Goto's attention. Originally represented by two completely separated right and left sacs, these spaces have at the period of the first stage studied completely fused in the region of the præoral lobe. The left one is sharply constricted into anterior and posterior portions, and the right undergoes a similar constriction somewhat later. In *Asterina gibbosa*, it will be remembered, there is not only constriction, but also complete separation into two parts in the case of both cavities. The left posterior cœlom assumes a U-shaped form, sending out dorsal and ventral horns. A portion of the right posterior enterocœle is cut off from the rest and forms a closed sac, the "epigastric" cœlom subsequently occupying an aboral position in the young starfish. The remainder of the right posterior cœlom fuses with the left posterior cœlom. The anterior cœlom becomes completely cut off from the posterior cœlomic sacs, and with the diminishing præoral lobe becomes largely obliterated, a portion persisting, however, as the axial sinus. In the septum dividing it from the left posterior cœlom, the stone canal is formed as a groove; this accordingly takes place long after the formation of the pore canal.

Simultaneously with the diminution in size of the anterior cœlom, the watervascular rudiment, present from the first stage as a posterior swelling on the anterior cœlom, becomes completely separated from the axial sinus, the only communication remaining being that *via* the stone canal.

The axial sinus gives off a diverticulum, which forms the dorsal sac of Bury — a structure denominated by me the right hydrocœle. According to Goto, it originates on the left side of the larva.

A peculiar diverticulum of the left posterior cœlom, mistaken by Ludwig ('82) for a rudiment of the "heart," gives rise to a space surrounding the adult œsophagus, and is named by Goto periœsophageal cœlom. It was called by me "oral cœlom."

Lastly, Dr. Goto discusses cavities of "mesenchymatous" origin. Under this heading he includes the peribranchial cavities surrounding the dermal gills, or papulæ, and the radial perihæmal canals, together with the outer perihæmal ring. These spaces, according to him, originate entirely independently of the cœlom by the hollowing out of originally solid masses of mesenchyme cells. The inner perihæmal ring, on the contrary, is an outgrowth of the axial sinus.

Seitaro Goto confirms my statements as to the total want of homology between the aboral poles of the asteroid and crinoid, the origin of the axial sinus and the stone canal, and the persistence of a communication between them, and the origin of the perioesophageal cœlom and of the inner perihæmal ring. On the other hand, the results of my investigations, which seemed to me the most interesting and important, namely, the primitive segmentation of the cœlom, the existence of a right watervascular rudiment or hydrocœle, the presence of a permanently fixed stage in the ontogeny, and the denial of the existence of any spaces of mesenchymatous origin, are not confirmed by Goto.

It will conduce to brevity and clearness if I state shortly and definitely my position with regard to this discordance in opinion. I am convinced, from the general outline given by Goto, that the development of *Asterina gibbosa* and the development of *Asterias pallida* are in all essential points identical in character. I have submitted my own sections to reëxamination, after reading Dr. Goto's paper, and find them decisive; and I find enough imperfection in Dr. Goto's methods to more than account for all the differences between us.

My work was based on hundreds of complete series of sections of larvæ fixed by a method which was selected, after a long series of trials, as preserving the outlines of the organs with the sharpness of the lines in a steel engraving. I find no evidence whatever that Dr. Goto examined anything comparable to the number of larvæ seen by me, and the method of preservation adopted by him is one of the worst suited for the purpose.

I do not question the accuracy of Dr. Goto's statement as

to the backward displacement of the disk of the young starfish; but I regard the coincidence between the sagittal plane of the larva and the vertical plane drawn through the madreporic pore and the mouth of the adult as an accidental agreement of no deep significance. The backward movement of the disk does not take place to anything like the same extent in *Asterina gibbosa*. It remains true there, in spite of Dr. Goto's denial, that right to left in the larva is nearly dorsal to ventral in the adult. Sections orientated parallel to the frontal larval plane have given longitudinal sections of the stone canal which would be impossible were the relations of adult and larval planes such as described by Dr. Goto.

With regard to the absence of the fixed stage, it is to be regretted that Dr. Goto has given us no information as to how he obtained his larvæ — whether they were reared from the egg, or whether they were obtained by the use of the tow net. Ludwig failed to find the fixed stage in *Asterina gibbosa*, probably because the larvæ were not provided with a suitable substratum; and if Dr. Goto fished his metamorphosing larvæ out of the sea, it is quite conceivable that the time when fixation could occur was past, or that no suitable basis was provided for fixation. Glass is assuredly not such a substance; I never saw an Asterina larva fixed to glass; and it is surely not probable that the brachiolarian arms are developed for no purpose.

I come now to what I regard as one of the most serious points of difference, namely, the meaning of the sac called by me the right hydrocœle. In support of this position, I gave not only a clear account of its appearance unequivocally on the right side of the larvæ, but I also described a number of cases where exceptionally the sac had undergone further development, and produced lobes similar to those formed by the left hydrocœle. Now, Goto has not seen the origin of the structure at all, this occurring at a stage considerably previous to any which he has figured, and his statements as to its later connection with the axial sinus are entirely due to the preservation of his larvæ. Many times in the earlier portion of my work was I tempted to make the same statement before I found out that corrosive sublimate was unsuited for the preservation of these larvæ.

The account given by Goto of the segmentation of the body cavity is also most unsatisfactory, and raises the suspicion of many stages having been missed out. At any rate, he gives no ground whatever for his belief that the "epigastric" cœlom is only a portion of the right posterior cœlom, for he has not shown how he can define the latter space. The stages he describes recall the period in Asterina development when the segmentation of the cœlom, after being formed, has to some extent broken down; and as it is in the highest degree improbable that *Asterina gibbosa* has a more circuitous development than *Asterias pallida*, a reëxamination of this point, based on more abundant material, would probably put a different complexion on the affair.

The criticisms made above with reference to the right hydrocœle apply with tenfold greater force to the origin of the perihæmal cavities. These originate long before Seitaro Goto saw the first trace of them. As to their origin from the cœlom, not the slightest doubt can exist in the mind of any one who has seen a properly prepared section of a metamorphosing Asterina larva. I have figured one of these rudiments under the magnification obtained by a Leitz immersion, putting in the outline of every cell, in Fig. 139 of my paper ('96), and the communication with the cœlom is no dubious slit, but a broad opening. This opening surprisingly soon closes up, and in later stages one could imagine the space to be of mesenchymatous origin, if one had not seen the earlier stages.

I may say definitely that I am very sceptical as to the mesenchymatous origin of any cavity. The mesenchyme is primarily a series of amœbocytes floating in a cavity, which answers retrospectively to the jelly of cœlenterata, and prospectively to the hæmocœle of the higher animals. That these amœbocytes should first coalesce, and then hollow out to form a cavity within a cavity, seems exceedingly improbable, especially when one remembers how easy it is by missing out stages to lose entire sight of the genetic connections of two organs.

In conclusion, I must remark that Seitaro Goto's work is not suited to solve the problems he attacks. Echinoderm larvæ are most difficult objects to handle. Bury himself ('95)

remarks that his early results are unreliable, because he had not imbedded in celloidin, — a statement with which I fully concur, — and it never seems to have occurred to Goto to use celloidin. Osmic acid, again, is the only reagent which will preserve the delicate epithelia so that one can be sure of their actual extent. And Goto used corrosive sublimate mixed with glycerine, an absolutely fatal compound for histology. Again, so far as one can judge, a most insufficient amount of material was used. And there is no subject on which it is so easy to go fatally wrong as organogeny, except an unbroken series of stages be obtained.

We have now reached a stage in embryological research where progress can only be made by the most refined methods, and by the exercise of abundant caution. The day of breaking ground is past. Of course the method of thorough exploration by sections is slow and laborious, and in these days of impatience for quick results it is apt to be shirked; but in my opinion it is the only one which will lead us any farther in our acquaintance with developmental processes.

MONTREAL, October 22, 1898.

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EDITORIALS.

The American *vs.* the British Association for the Advancement of Science. A Comparison. — Comparisons may be odious, especially to the less favored party, but they nevertheless afford the best means for determining shortcomings and the way to improvement. For years we in America have been asking why our Association is so inferior to that of Great Britain; why it is so much less representative of science in the country. Perhaps a detailed comparison of the two Associations will tell us.

The British Association has a membership of about 5000; the American Association of about 2000. The British Association has invested funds, including balance in banks, of nearly $70,000; the American Association has about $6,000. The meetings of the British Association are attended by from 1300 to 4000 paying members and "associates"; the American Association had an attendance at its Detroit meeting, in 1897, of less than 300; at its Boston meeting, in 1898, of about 900 "registered delegates." The published *Report of the British Association* for 1897 contained 1132 pages; the *Proceedings of the American Association* for 1897 had 579 pages, very largely matter of transitory value. The membership of the British Association admittedly and evidently includes practically all the scientific men of Great Britain. In the American Association it is the absence of many of the most important names which is striking. Thus, of the professors of all grades in the twenty principal universities and colleges of the United States, we find that the members of the American Association constituted in physics about 54 per cent; in chemistry, 51 per cent; in geology, 74 per cent; in biology, 27 per cent. The British Association voted, in 1897, $5295 in grants; the American Association, $400. On the other hand, while the British Association expended $2770 in salaries, rent, and office expenses, the American Association spent $2867 on these items. Thus, while the British Association spends 24 per cent of its receipts upon research, ours spends less than 7 per cent; but while our cousins devote 13 per cent of the gross receipts to salaries and office expenses, we spend thus 48 per cent.

Various causes have been assigned for this difference between the two Associations. The small membership and attendance at the

meetings of our Association have been ascribed to the large size of our country. Nearly all the British meetings are held in Great Britain proper, the extreme distance between meeting places on this island being less than 500 miles. On the other hand, the average distance between the successive meeting places of the last seven meetings of the American Association was 767 miles, and the extreme range about 1700 miles. To have attended all the meetings since the one in Boston in 1880, a Boston member must have traveled about 28,000 miles, or one and a half times the distance around the earth at this latitude. Even at a two-thirds fare this would have cost him over $500 in car fare alone, not to mention the discomforts of long journeys. The Boston member who has to economize is fortunate if he can attend two meetings in a decade, and the same is true of the member from Washington or Minneapolis. Thus the great distance between successive meeting places prevents a continuity in the attendance, and this results in loss of interest and interferes with that continuity of endeavor which is essential to the systematic direction of scientific research and the attainment of increased facilities for scientific men. On the contrary, our society seems itself to lack direction. The council of one year votes to cut out all abstracts of papers from the *Proceedings*, and that of the next year rescinds the vote. One year, at one place, a member arouses enthusiasm enough to get a committee appointed to conduct some investigation; and next year, at a place 1000 miles away, nobody hears about the committee, which is discontinued or continued with the "*personnel* the same as last year." There are only two remedies for this state of things; either to break up the Association into Atlantic, Mississippi, and Pacific branches, or else to make the meetings so interesting and valuable that members will attend them despite expense. The latter solution seems to us the best one to work toward.

What can be done to secure this increased interest? This is the vital question. No doubt the determination by the best scientific men of the country to attend the meetings, at the sacrifice of time and money, is the first step. To get this step, however, seems to demand certain reforms. First, the finances should be improved. Cut down salaries, office rent, and office expenses. The American Society of Naturalists, which issues *Records* of nearly fifty pages, pays less than $50 per year for clerical assistance. Why cannot the American Association get along on $1000 a year for salaries? This would release over $1000 for grants for research. The grants would call forth new committees. Formal reports should be required from

each committee, and these should be printed in the *Proceedings*. The value of the *Proceedings* will be thus enhanced and a more general interest will be awakened among scientific men in the work of their Association.

To carry on the enlarged work of the Association, additional funds will have to be acquired. The plan adopted by the British Association, of making visitors and ladies accompanying members pay for the privileges of the meetings, seems to us in every way admirable. The income of the British Association in 1897 was £580 from annual assessments, but £2242 from non-members. Thus the non-scientific contributed to the support of science. Finally, to increase the membership of the Association, a systematic canvas should be made of the scientific societies of the country, to the ends that their quality may be determined; that we may accept, as it were, "on certificate" and without special election, any member of a suitable society; and that these societies may be led to coöperate with the national association in promoting the interests of science in the land.

Zoological Bibliography. — The second report of the committee of the Royal Society upon Zoological Bibliography and Publication has been issued. It contains the following suggestions:

(1) That each part of a serial publication should have the date of actual publication, as near as may be, printed on the wrapper, and, when possible, on the last sheet sent to press.

(2) That authors' separate copies should not be distributed privately, before the paper has been published in the regular manner.

(3) That authors' separate copies should be issued with the original pagination, and plate numbers clearly indicated on each page and plate, and with a reference to the original place of publication.

(4) That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible.

(5) That new species should be properly diagnosed, and figured where possible.

(6) That new names should not be proposed in irrelevant footnotes or anonymous paragraphs.

(7) That references to previous publications should be made fully and correctly, if possible, in accordance with one of the recognized sets of rules for quotation, such as that recently adopted by the French Zoological Society.

With all of which the *American Naturalist* is in the closest sympathy. A few comments, however, may be of interest. The second of the

above rules meets with objection on the part of some, who claim that in the case of societies which publish irregularly and at long intervals, it seems wrong to withhold the extras until the whole volume is published. This frequently would result in a delay of months, or even of years. For instance, one volume of the *Transactions of the Connecticut Academy of Arts and Sciences* has been kept incomplete for over a dozen years, awaiting the dilatoriness of an author who has failed to submit the manuscript of an article accepted for publication. All such difficulties, it seems to us, would be obviated by following the course adopted by several societies, among them the Boston Society of Natural History and the American Academy of Arts and Sciences, of issuing each paper separately as soon as it is ready.

In regard to Article 4, we wish that the committee could have gone farther, and have expressed its opinion of a tendency to split up what should form a single article into a number of articles, each with its own heading. We recall one extreme case of a single volume, in which an author had over a dozen articles upon the larval stages of as many different Lepidoptera, each with its own title, and each, by all rules of bibliography, entitled to rank as a separate article, while all might readily be embraced under a single heading. Similar cases abound in the literature of species describing; and their only excuse seems to be that the authors wished to have as many titles as possible to their credit (?) in the bibliographies.

The sixth suggestion is one that if followed will eventually bring to an end a host of trials and tribulations of the systematist. Such names are almost sure to be lost for years. For instance, the late Dr. Haldemann years ago described the crustacean genus Abacura. How many carcinologists know of the description? Then, what shall be done with isolated descriptions in school books? And what with suggestions like the following? In *Science*, Vol. viii, No. 201, p. 613, Dr. Dall, in a notice of Bitners's Lamellibranchs of the trias of St. Cassian, speaks of the preoccupied name Arcoptera and says, "We would suggest that the preoccupied name be replaced by Bittnerella." This occurs in an article which would be apt to be overlooked by the systematist; and again this able conchologist does not actually rename the genus but suggests that it be renamed, as if fully cognizant of the incongruity of time and place.

The Utilization of Desert Areas. — With the increase of our population the extent of our desert areas has constantly diminished through the use of crops adapted to the climate and by irrigation,

so that lands once thought to be uninhabitable are now veritable gardens. One of the most forlorn-appearing regions is the Red Desert of Southwestern Wyoming, which has of late years become an important winter pasture ground for the herds and flocks which feed by summer in the adjacent states. A careful study of the forage plants of the Red Desert, by Prof. Aven Nelson, has just been issued by the Department of Agriculture. It enumerates a large number of salt sages, sagebrushes, grasses, and sedges found in the desert, and figures many of them. The work is important, not merely economically, as giving suggestions for agricultural plants adapted to desert regions, but also as a contribution to the knowledge of the adaptations of desert animals.

Animal Photographs. — Photography is rapidly becoming in a variety of ways one of the necessary tools of a working naturalist, and one of its most important uses is in connection with the production of process figures to illustrate zoological works. The immense superiority of such figures over the conventional woodcuts could not be better shown than in Dr. R. W. Schufeldt's article on "Some Characteristic Attitudes of the Red Squirrel," in the June *Photographic Times*. A zoological text-book, illustrated by such figures as these, would be a pleasure to every lover of animals, as well as a source of information.

We learn that entomological books of all kinds can be imported into Canada free of all customs duties. We, in the United States, have a tariff expressly designed for the protection of ignorance. Books in the English language can be imported duty free only when over twenty years old.

REVIEWS OF RECENT LITERATURE.

Animal Psychology.[1] — Every book which comes to us from the direct and faithful observer of psychical development in the lower animals is doubly to be welcomed: first, for our abiding interest in them which makes every trait of theirs worth knowing for its own sake; and, second, for the light which a study of their nature throws upon the problems of human psychology. Among the latest of these contributors is Prof. Wesley Mills, of McGill University, Montreal, who has been known for a score of years as a successful breeder of dogs and a close student of the habits and development of this and allied species of animals. The book consists of four parts. The first of these comprises a group of essays and addresses upon the methods and the value of Comparative Psychology; the second deals with the phenomena of hibernation, feigning and allied states among animals, and with analogous states obtaining in human subjects; the third and most important section of the work consists of detailed original observations upon the physical and psychical development of animals, supplemented freely by constructive criticism; and in the fourth is added the reprint of a series of discussions upon the nature of instinctive tendencies, which appeared originally in *Science*, 1896. The papers which form the preceding parts of the book were first published in *Science*, *Popular Science Monthly*, and other periodicals, and in the *Transactions of the Royal Society of Canada.*

Professor Mills comes to his work well fitted by years of patient and direct study of animals in his own warrens and breeding kennels; and only such work as his will be of final value for the science of animal and comparative psychology. "Closet psychology," he says, "cannot hope to accomplish much." "He who would understand animals thoroughly must live among them, endeavor to think as they think and feel as they feel, and this at every stage in their development."

At the outset the author makes plain his conception of the impulse to animal study and the nature of its problems. Our interest is based

[1] Mills, Wesley, M.A., M.D., F.R.S.C., etc., Professor of Physiology in McGill University, Montreal, Canada. *The Nature and Development of Animal Intelligence.* The Macmillan Company, 8vo., pp. 300. $2.00.

upon an interpretation of animal nature through the analogy of our own. "We make the world of animal life about us a reflection of ourselves; we spontaneously implant in the bird and the squirrel qualities that are our own. They interest us in proportion as they seem to embody the same thoughts and feelings as ourselves." But this is not the only, nor, indeed, the most important aspect of the study. The science of physiology has grown up almost wholly through experiments performed upon the lower animals; we must apply the same method to psychology; to understand adequately the processes of the human mind, we must study the nature and development of more primitive forms of life. A few words will indicate the relations in which the results of animal psychology have an important bearing upon the questions of human psychology.

It is scarcely a generation since the first psychological laboratories were founded; but in the brief years which have intervened between that time and this there have grown up dozens of such experimental stations, in which skilled observers carry on patient and detailed study of the phenomena of our mental life.

One of the chief difficulties which these experimental psychologists have to solve is the production of a naïve attitude in the subject of the experiment. The mature human being is a mass of ingrained conventions which very greatly transform his original impulses. The primary reaction, the elementary motif, the native trend of desire, the unqualified conviction, are overlaid and disguised by a thousand modifying considerations and restraints imposed upon him by the very form of his social life. He clothes himself in inhibitions as in a garment, and anything which will aid in stripping off this fabric of secondary impulses, and secure for the student a direct observation of the naked tendency, is to be welcomed for the light it throws upon the complex object of his study.

To simplify the conditions under which the mental process takes place, and at the same time to maintain its typical character, is the problem of the psychological investigator; and to fulfill these requirements he goes far afield from the study of the normal adult subject and calls many diverse observers to his aid.

The pursuit of these simpler conditions has gone in two main directions: first, into the province of pathology, where abnormal variations have presented certain elements so heightened in value that the network of ordinary inhibitions has been torn away and the exaggerated impulses can be observed with a directness unattainable in the normal individual; and, second, into the realm of more primi-

tive forms of life, in which the activities common to them and the mature human subject have not been obscured by the counter-play of motives and restraints. Observations in both these fields are accumulating at an immensely rapid rate. Psychiatry has a literature of its own, while the index to works on hypnotism, hysteria, and allied states fills a volume of itself. One can scarcely take up a periodical — popular or technically psychological — without running across either a monograph on this or that phase of child-study, or a notice of some new book on the subject. The habits and peculiarities of the lower species of animals, the character of their sense perceptions, and the nature of their intelligence have long been studied, but rather as classes apart from each other and from man, and not as members of a common genetic group. We need a truly comparative psychology, which, by diligent study of the psychic life of all orders accessible to observation, will seek to show us what the intimate nature of the process of mental development actually is, and to trace back the developed processes manifested in the higher species to their roots in the primitive forms of action and reaction which comprise the mental activities of the more elementary forms of life.

The reflex and subliminal regions of consciousness are full of unsolved problems; instincts, automatisms, whims, and idiosyncrasies, and all such marginal phenomena are things out of the unplumbed depths of our nature upon which biological psychology is bound to pour a flood of light. We need a paleontology of the soul, and the only instrument at hand by which we can probe the region of its vanished growth is that of comparison with the activities of those simpler forms which are now to be found in the child and the lower animal. The child is always with us, and it needs but patience and faithfulness of observation to exploit its nature; but for the study of lower forms of life we need laboratories, of which aquaria and vivaria are but the beginning, in which systematic observation of a wide variety of animal life shall be carried on. Already a move in this direction has been made by more than one university; an increasing number of students are coming to us from zoological museums and laboratories, and many signs point to a rapid and extensive development of biological psychology.

The work which the laboratory of biological psychology shall carry on more systematically and comprehensively, — the patient and sympathetic study of wild and domestic animals, vertebrate and invertebrate alike, — has already assumed great importance at the hands of many individual investigators, who, like our author, look upon the

whole animal kingdom as parts of one genetic scheme, in which the activities and traits of the beasts find their significance not through any fanciful analogy, but because they are the actual prototypes of the mental processes of the human mind itself. "If we regard man as the outcome of development through lower forms, according to variation with natural selection — in a word, if man is the final link in a long chain binding the whole animal creation together, we have the greater reason for inferring that comparative psychology and human psychology have common roots. We must, in fact, believe in a mental or psychical evolution as well as in a physical (morphological) one" (p. 20).

Into the detailed results of Professor Mills's work we cannot enter here, but the problems with which comparative psychology has mainly to grapple can be stated in a few lines.

1. Imagination in animals, the power to frame mental pictures of absent objects.

2. The fact and extent of the power to count and deal with measurable quantities in general.

3. The capacity to generalize upon details and to form abstract ideas.

4. The sense of right and wrong, and the nature of moral sanction among the brutes.

5. Their comprehension of man's various forms of expression and the extent of their power of communication between each other.

6. The homing and migrating instincts of animals and their reappearance in man.

7. The laws of heredity and susceptibility of animals to modification through environment.

Towards the solution of these problems Mr. Mills professes to contribute only material; he is sparing in his deductions and faithful to the fact. "Plainly," he says, "it will be desirable to keep our facts very sharply apart from our explanations. The science of psychology is a very youthful one; that of comparative psychology still more so; and at the present stage of the science any one who contributes a single fact will be a real friend to its progress." The book is chiefly contributory of material, it is true, and such work is long in process, and its conclusions concerning individual functions and species of animals are fragmentary and tentative; but such delving must necessarily precede and underlie all constructive theory.

Mr. Mills's work shows in a marked degree a qualification upon which must be founded all really successful study of animal life;

he is a lover of dumb beasts as well as a student of their ways; and throughout his writing there breathes a frank and open spirit of inquiry, and a fitness of style which increases the acceptability of his work. In its sympathy and kindly appreciation for animals, its modesty, and its sanity and moderation of statement, the book is one of the most hopeful of recent contributions to the study of animal intelligence.

ROBERT MACDOUGALL.

CAMBRIDGE, MASS.

We have received the volume of *Naturæ Novitates* for 1897 from the publishers, R. Friedländer & Sohn, Berlin. This useful work, comprising, as it does, notices of all the more important books and articles of the year in Natural History and the exact sciences, together with valuable Personalia, deserves to be more widely known and used in this country.

GENERAL BIOLOGY.

Animal Grafts. — In the *Sitzungsberichte der Gesellschaft zu Marburg*, Jahrgang 1897, F. Marchand describes several sets of successful experiments in grafting one part of the body upon another part. Thus, in the rabbit he has transplanted the cornea of the eye from one animal to the eye of another, and the transplanted part has taken root, as it were, so that in time the eye appears normal. He has repeated the older experiment of ingrafting the tail of a young rat under the skin of its own back. The tail continues to grow as it would have done in its normal position. The tail makes connections with the blood system of the body in its new location, and these connecting vessels become large enough to carry on the nutrition of the parasitic tail. It is a case of perfect adjustment of the organism to new conditions.

Regeneration of Extirpated Limbs. — Miss Byrnes (*Anat. Anz.*, 1898) has destroyed, by means of a hot needle, the body-wall musculature in young tadpoles at the point where limbs were about to arise. Soon after the operation the cells lying ventral to the wound pushed up and closed it. From this tissue, which normally has nothing to do with forming the limb, the limb arises in normal form and size. [It may be added that this result is less properly called regeneration, which more frequently implies development from a rudiment of the regenerating organ, than regulation, by which a part — the ventral

body-wall — assumes an entirely new function — the formation of a limb — because of the peculiar needs of the organism.] C. B. D.

The Journal of Comparative Neurology[1] begins its eighth volume with a commendable number of original contributions and its usual full series of literary notices. Dr. Alfred Schaper gives an account of the finer structure of the Selachian cerebellum, as shown by chrome-silver preparations. Dr. P. A. Fish describes the brain of the fur seal, *Callorhinus ursinus*, and discusses the nerve cell as a unit. C. L. Herrick contributes three articles: one on the "Physiological Corollaries of the Equilibrium Theory of Nervous Action and Control"; a second "On Cortical Motor Centres"; and a third, in conjunction with G. E. Coghill, on the "Somatic Equilibrium and the Nerve Endings in the Skin." The number of collaborators on the *Journal* has been increased, and now includes Prof. H. H. Donaldson, Prof. L. Edinger, Prof. A. van Gehuchten, Prof. G. C. Huber, Dr. B. F. Kingsbury, Prof. F. S. Lee, and Dr. A. Meyer. G. H. P.

Physiological Archives. — The University of Chicago has published a second volume of *Physiological Archives*, under the editorship of Professor Jacques Loeb. The volume contains seventeen contributions, mostly reprints from articles by Professor Loeb and his pupils, and affords substantial evidence of the activity of the Hull Physiological Laboratory. G. H. P.

We are glad to see that the Macmillan Company announce for early publication *General Physiology; an Outline of the Science of Life*, by Max Verworn, M.D., Ph.D., Professor of Physiology in the Medical Faculty of the University of Jena. Translated from the second German edition and edited by Frederic S. Lee, Ph.D., adjunct Professor of Physiology in Columbia University.

ANTHROPOLOGY.

Observations on the Muscular Variations of the Human Races.[2] — Notwithstanding the exhaustive studies that have been devoted to the human skeleton, there yet remain many unsolved problems pertaining to the relation of culture, environment, and race to the

[1] *The Journal of Comparative Neurology*, vol. viii, July, 1898, Nos. 1 and 2.

[2] Chudzinski, Th. Observations sur les variations musculaires dans les races humaines, *Mémoires de la Société d'Anthropologie de Paris*; 1, ii, Fasc. ii, 1898.

form of the skeleton. Much less is known concerning the effect of these factors upon the more perishable portions of the body. The material is not agreeable to handle and the opportunity comes to but few. Dr. Théophile Chudzinski improved the opportunity which presented itself to him during the period of twenty years in which he was connected with the laboratory of the School of Anthropology of Paris, and published the results of his indefatigable investigations in the field of comparative myology in a number of papers upon the variation of the muscles in the different races. From the vast quantity of laboratory notes and manuscripts which he had accumulated Professor Manouvrier announces in an introductory note that a number of papers are to be published soon. The present memoir deals with thirty-five muscles, chiefly those of the upper extremities. The known variations of each muscle are considered with frequent allusions to dissections by the author other than those represented in the succeeding tables; then a section is devoted to the comparative anatomy of the muscle; this is followed by a presentation of the "Anthropological" characters, with tables showing the mean, maximum, and minimum dimensions, insertions, etc. The "Conclusions" briefly recapitulate the facts presented in the case of each muscle. The use of a different kind of type in these summaries would have enhanced the value of the work. It is not claimed that the results are final, nor is the classification of the subjects dissected, as *noire* or *jaune*, above criticism. However, the memoir contains a rich store of information for the somatologist.

Publications of the Société d'Anthropologie de Paris. — The publications of the French society consist of its well-known *Bulletins* and a series of original *Memoirs*. In No. 1, Vol. ix, of the *Bulletins* appears a reprint of the constitution and by-laws of the society, together with a list of its members. Four prizes, amounting to 4500 francs, are awarded by the society for papers upon anthropological subjects; neither "sex, nationality, nor profession" debars any one from competition.

In the first article of the constitution it is stated that the object of the society is the "scientific study of the races of mankind." By this definition the scope of its operations is so broad that we turn to its publications to learn how this study is carried on. The number of the *Bulletins* mentioned contains nine articles, including abstracts, three of which are upon somatological, and the remainder upon archæological subjects. Important ethnographic papers are occa-

sionally published in both *Bulletins* and *Memoirs*, but the field of activity of the society is, for the most part, limited to two divisions of the science of anthropology.

Professor Manouvrier, in *Bulletin* No. 2, Vol. ix, reports the existence of a remarkable case of ichthyosis in a peasant forty-seven years of age, from the Department of Lot-et-Garonne. Nearly the entire surface of his body is covered with scales, generally quadrangular, and in places imbricated. The deformity is congenital and has not affected the health of the subject. That it is a case of atavism is suggested, but the supposition cannot be proven. M. Zaborowski gives an interesting account of the affinities of the tribes of Western Siberia, particularly of the ancient peoples whose skeletons are found in the dolmens of that region. It is a relief to note that a very moderate number of measurements is considered sufficient to establish the racial type ; brevity is the soul of craniology. After a careful investigation, in which he rejected the usual indices, M. R. Anthony arrived at the conclusion that the variations of the sternum in the mammalian series can best be represented by an index derived from the breadth and thickness of the presternum. This index is higher and more ape-like in the Australians, Negritoes, and Hottentots (above 40) than among Europeans (32.4). Dr. Adolphe Bloch presents the results of his investigations upon the number of phalanges in the fifth toe of the human foot. He states that the anomaly of two phalanges instead of three occurred, according to Pfitzner, in 37.2 per cent of the 799 feet examined. Dr. Bloch's observations upon a smaller series resulted in the discovery of so large a number of cases that the toe with two bones seemed to be the normal one, and the toe with three phalanges the anomaly. He inclines to accept Testut's opinion that the reduction in the number of phalanges in the fifth and other toes is a progressive modification due to the adoption of the erect attitude by man.

FRANK RUSSELL.

ZOOLOGY.

The Birds of Indiana. — The previous catalogues of Indiana birds having become antiquated and out of print, Mr. Amos W. Butler has given us the results of twenty-one years of study of the birds of his native state in a stout volume of 673 pages,[1] forming a

[1] Butler, Amos W., Indianapolis, Ind. *The Birds of Indiana.* A descriptive catalogue of the birds that have been observed within the state, with an account

useful handbook, containing keys for the determination of the species, as well as brief but sufficient descriptions of each bird undoubtedly observed within the confines of the state. By strictly following the nomenclature adopted by the American Ornithologists Union, he has avoided the necessity of synonymic lists, and on the whole the technical matter has been reduced with commendable discretion to the smallest practicable compass, thus leaving ample space for observations regarding distribution, habits, economic importance, etc. The technical matter is chiefly compiled from well-known manuals, for which due credit is given, and calls for no comment here, except that the compilation seems to have been done with care and judgment.

The chief value of the book lies in the original observations of the author, and the student will here find a rich store of facts to ponder upon. The agricultural man will learn which birds to regard as friends, and which to treat as enemies; he will find many of his prejudices and superstitions combated, but he has been given large and convincing series of facts ascertained by the author, or gathered by him from other reliable sources, notably from the publications of Dr. Merriam's division of ornithology of the United States Department of Agriculture. The lover of the feathered tribes will find many interesting bits of information concerning the habits of his favorites, and special attention has evidently been paid to the calls and songs of the various species. Young beginners and local ornithologists will find the book a reliable guide among their specimens, and sportsmen have an easy means of identifying the contents of their bags. Ornithologists of wider sphere will find it a treasure of detailed facts relating to distribution and migration, which it will repay them to exploit.

Ornithology is even now looked upon by many zoologists more as a pleasant pastime than a serious science, more fit for an amateur than for a working natural philosopher. It is true that ornithology, perhaps more than any other branch of zoology, is burdened with the ills resulting from a large number of irresponsible amateurs, but I think it is equally true that no branch, on the other hand, is indebted to non-professional co-workers for most valuable help to the same extent as ornithology. The book before us not only illustrates this point to perfection, but a perusal of it will also convince the most sceptical that in exactness and methods the ornithology of to-day is

of their habits. *From the 22d Report of the Department of Geology and Natural Resources of Indiana, 1897. W. S. Blatchley, State Geologist*, pp. 515–1187.

not behind the other sections of descriptive zoology; nay, it may even be said in truth that it has shown the way to many of them. But if the technical part of this science is not behindhand, certainly the object itself is not inferior in general philosophic interest to that of any other branch of zoology. The study of birds has helped throw light on many obscure questions in geology, paleontology, and evolution, and the sooner the ornithologist is enabled to settle all the little questions of detail, which seem so unimportant to outsiders, the sooner will he be able to contribute to the solution of the higher problems. The avifauna of this country is probably better known than that of any other area of even approximately similar extent, yet much is to be done, and in bringing forward its share of the material the book under review is valuable to the most advanced student. Take the case of Kirtland's warbler (p. 1070), for instance. The history of this bird as there set forth is most suggestive and extraordinary. The first specimen was taken at sea, off Abaco Island, one of the Bahamas, in 1841, and the species has since been discovered to pass the winters in that archipelago. Ten years later a specimen was captured near Cincinnati, Ohio, by Dr. Kirtland, for whom Professor Baird named the species. Mr. Butler enumerates twenty specimens as having been seen or killed in North America since then; all these were observed during the spring or fall migrations with possibly one exception, and outside of its winter haunts this species has not been met with elsewhere. Where does it pass the summer; where does it lay its eggs and rear its young? Nobody knows, and we have only surmises. If we draw a straight line from the northwestern end of the Bahamas to the middle of the state of Michigan, we will see that the localities where specimens of this curiously rare bird have been found are either situated nearly on this line or close to it on both sides, *viz.*, in South Carolina, Ohio, Indiana, and southern Michigan; while a few others have been taken at points considerably off the line, as near Minneapolis, St. Louis, and Washington, D. C. These are all the facts which the ornithologists, in spite of the utmost efforts, have been able to bring together during a search of nearly fifty years! And what do these facts suggest? First, let it be stated, that nearly all the facts have been brought to light by non-professional observers; next it may be noted that as ornithology became more popular, and amateurs more numerous, the observations also became more frequent; it is also highly suggestive that the country between South Carolina and Ohio, through which the annual migrations of this bird almost to a certainty take

place, is less frequented by amateur ornithologists than probably any other part of eastern North America; the inference then is pretty plain that if we had more of the right kind of amateurs we should probably also have more facts with which to answer the question — where does this bird summer, and where lies its exact migration route?

The importance of this question is very great, for, seemingly at least, the distribution of this warbler suggests a migration route almost unique. Yet, if we accept as our working theory of migration the only rational one which has been offered to the present day, *viz.*, Palmén's, that the annual migration route of a species indicates the way by which it originally immigrated into its present breeding home, how are we going to explain the apparent uniqueness of the route of *Dendroica kirtlandii?* It must not be forgotten that it is extremely difficult, if not impossible, to trace the individual migration paths of a homogeneous species covering a large area and occupying a multitude of routes between its vast summer habitat and its equally extensive winter quarters, and that, even in cases where the birds of a widely distributed species have evolved slightly differentiated forms traveling on their own migration routes, it requires the keenest power of discernment in the sharpest bird expert to trace these routes. How can we tell but that many of the homogeneous species occupying the whole area of eastern North America do not in part follow a route similar to that of Kirtland's warbler? It will now be seen how desirable it is to trace step by step the progress of this species from the Bahamas to Michigan, and possibly beyond. Here is a species so very strongly differentiated as not to be mistaken for any other, and so limited in numbers that it probably follows only a single narrowly limited route. When we shall have solved this problem we shall also know a good deal more about the road by which in past ages part of our fauna entered their present habitat.

There remain only a few words to be said about the illustrations in Mr. Butler's book. None, as far as I have discovered, are new, and they would have received no special mention had the selection been good in all cases. We notice with pleasure all the characteristic and accurate bird portraits from John L. Ridgway's pen, furnished by Dr. Merriam's division in the Department of Agriculture, but we must earnestly protest against the presence of a number of antique caricatures — borrowed, it is true, from a book which still periodically appears in the market — which neither illustrate, because it is impossible in most of them to recognize the birds they are

intended to represent, nor lend artistic charm to the page, since they are equally vile, whether meant for pictures only or for ornithological drawings. As startling examples, we may mention the figures on pp. 737, 760, 817, and 997, labeled, respectively, Golden Plover, Passenger Pigeon, Snowy Owl, and Tree Swallow. It is also to be regretted that any of the woodcuts from Brehm's *Thierleben* (pp. 606, 1001) should still be used in an American book, after all that has been written about them. Otherwise the book, which has several interesting introductory chapters and an exhaustive bibliography, is gotten up very well and takes a high rank among similar works.

LEONHARD STEJNEGER.

Trouessart's Catalogue of Mammals, Living and Extinct.[1] — Mammalogists owe to Dr. Trouessart a large debt of gratitude for his Catalogue of Recent and Extinct Mammals, the publication of which is now nearing completion, four of the five fasciculi having already appeared. Considering the magnitude and difficulties of the task, the work is well done; we detect few omissions, and the number of clerical and typographical errors is not greater than is natural to expect in a work of this character. The classification followed is essentially that of Flower and Lydekker's "Introduction to the Study of Mammals," but the order of treatment is reversed, Dr. Trouessart beginning with the Primates and ending with the Monotremes.

No one can be expected to have expert knowledge of all the varied forms of even the class mammalia in this period of rapid advance in the discovery of new forms and of the relationships of hitherto obscurely known types. As the work before us is essentially bibliographical, serving as a systematic index to the species, genera, and higher groups of the mammalia, a few slips here and there in the allocation of species and subspecies, genera and subgenera, can readily be overlooked in view of the utility of this immense undertaking. The specialist will not be misled by the occasional lapses he may detect in the case of groups he has especially investigated, and they can hardly detract from the general usefulness and convenience of a work which will prove an enduring monument to the patience, industry, and scientific acumen of its author.

[1] *Catalogus Mammalium tam Viventium quam fossilium* a Doctore E. L. Trouessart, Parisiis. Nova Editio (Prima completa). Berolini: R. Friedländer & Sohn, 8vo. Fasc. i, Primates, Prosimiæ, Chiroptera, Insectivora, pp. 1–218, 1897; Fasc. ii, Carnivora, Pinnipedia, Rodentia, pp. 219–452, 1897; Fasc. iii, Rodentia, pp. 453–664, 1897; Fasc. iv, Tillodontia et Ungulata, pp. 665–998, 1898.

About 6000 species and 1183 genera, with probably nearly as many subspecies and subgenera, are marshaled in due order in the first four fasciculi aside from synonyms, with full bibliographical references to each, including not only the original place of description but nearly all of the more important subsequent references, including geographical references to localities. The labor involved in this compilation is thus beyond easy conception, and its value to Dr. Trouessart's fellow-workers is inestimable. J. A. A.

Generic and Family Names of Rodents. — Since the completion of that portion of Dr. Trouessart's *Catalogus Mammalium* treating of the Rodents, two important papers have appeared relating especially to the generic and family names of this numerous order of mammals. The first, by Mr. Oldfield Thomas, curator of mammals in the British Museum, is entitled "On the Genera of Rodents: an attempt to bring up to date the current arrangement of the order."[1] The other, by Dr. T. S. Palmer, of the Biological Survey, U. S. Department of Agriculture, is entitled "A List of the Generic and Family Names of Rodents."[2]

As noted by Mr. Thomas, one of the most important previous papers on the same subject was Mr. Alston's "On the Classification of the Order Glires," published in 1876. Mr. Alston was extremely conservative in his views, recognizing only 18 families and 100 genera, as against 21 families and 159 genera admitted by Mr. Thomas. "Of the additional 59 genera," says Mr. Thomas, "just about one-half are formed by the breaking up of old genera, and half are altogether new discoveries." Many old names, however, have had to be changed to bring them into conformity with current rules of nomenclature. On this point Mr. Thomas says: "It is with the greatest regret that I have had to use a good many names unfamiliar to English naturalists, but the evidence in every case is so clear as to leave no room for doubt, and none are mere matters of opinion. Recognizing that the ultimate use of these names is inevitable, I think the sooner a knowledge of them is disseminated the sooner will the intermediate stage of confusion be passed through and done with." Not only are we glad to see so eminent an authority take this sensible position, but we are also gratified to find that he rejects emendations, using names in all cases as originally published by the author proposing them. A seriously disturbing element in the sta-

[1] *Proceedings of the Zoological Society of London*, 1896, pp. 1012–28.
[2] *Proc. Biolog. Society of Washington*, vol. xi (Dec. 7, 1897), pp. 241–70.

bility of names is the tendency, on the part of a few wiseacres, to change names to suit their ideas of correct classical form, often to the extent of a radical transformation of an old name into a practically new one. It seems, for purposes of convenience, far better to extend the law of priority to the form of names as well as to the names themselves, since it is coming to be more and more generally accepted that a name is merely a convenient handle to a fact and need have no necessary significance. While it is desirable that all new names should be correctly formed, it is not necessary nor even desirable that old names should be discarded on account of faulty construction, nor even emended to suit our ideas of propriety.

Mr. Thomas divides the Rodents, as has long been customary, into two suborders — Simplicidentati and Duplicidentati, the latter consisting of the Hares and Picas, and the former including the rest of the order. The Simplicidentati are divided into five superfamily groups — Anomaluri, Sciuromorpha, Aplodontiæ, Myomorpha, Hystricomorpha. The families admitted in addition to those recognized by Alston are Bathyergidæ, Heteromyidæ, Erethizontidæ, and Pedetidæ. The American Porcupines are for the first time distinguished as a family from those of the Old World. References are given to the place of original description of the genera, but not for the higher groups; subgenera and synonyms are not included in the list.

Dr. Palmer's paper admirably supplements Mr. Thomas's, inasmuch as it gives references for the higher groups and includes subgenera and synonyms. The references here given for the higher groups are a great convenience, as they are generally omitted; a glance at Dr. Palmer's list, however, shows which among several names for the same group has priority. Dr. Palmer's paper is further "an attempt to bring together *all* the names, generic and subgeneric, ever proposed for Rodents." Reference to the place of publication is omitted, only the name of the author, the date of publication, and the type species, whenever determinable, being given, or in the absence of a type species all the species originally referred to the genus. Great care has been taken to give the actual date of publication, as distinguished from the ostensible or apparent date, wherever possible, as is the case in a large number of instances.

According to Dr. Palmer, the present list contains more than 600 generic and subgeneric names, or more than twice the number given by Marschall in 1873, and comprises about "15 per cent of the entire number of generic and subgeneric names ever proposed for mammals." The arrangement is strictly alphabetical as regards not

only the families but the genera and subgenera within the families, except in the case of the Muridæ, with its 200 names, which are alphabetized under the subfamilies.

These three lists — Dr. Trouessart's, Mr. Thomas's, and Dr. Palmer's — supplement each other admirably, the omissions in one being supplied by the other two, so that the work of the specialist in this group has now become greatly simplified and lightened as regards its nomenclatorial side. J. A. A.

A New Human Tapeworm. — In 1896 Prof. H. B. Ward, of the University of Nebraska, announced the discovery of a new human tapeworm, two specimens of which had been received by him from a Lincoln, Nebraska, physician. The new species was described as possessing characters in many respects intermediate between those of the two well-known species of Tænia found in man (*T. saginata* and *T. solium*), and for that reason was named by Ward *Tænia confusa*.

Only one of the two specimens received by Ward bore the scolex or head, which was "remarkably small," and unfortunately was detached by him for more careful study than was possible in its natural position. Ward's published description and figure of this scolex, he admits, would answer well for that of Dipylidium, and he is not now himself certain that he did not confuse the scolex, in the course of its preparation for microscopic examination, with that of a Dipylidium. That important portion, therefore, of the description of the new species, which concerns the scolex, must be held in abeyance until additional specimens are obtained.

Michael F. Guyer, a pupil of Professor Ward, in a recently published paper,[1] gives a detailed account of the anatomy of the new species as made out from a careful study of the specimens received by Ward in a headless condition and, unfortunately, none too well preserved.

Guyer finds that the proglottides of the new species are about as numerous as those of *T. solium*, but much longer and narrower, making its total length two or three times that of *T. solium*, and about the same as that of *T. saginata*, which, however, bears nearly twice as many proglottides. The branches of the uterus, one of the most conspicuous characters of a ripe proglottis, number from fourteen to twenty; in *T. solium* there are from seven to ten branches, and in *T. saginata* from twenty to thirty.

[1] *Zool. Jahr.*, Bd. xi (1898), pp. 1–24, Taf. 28.

Calcareous bodies are few in number, as in *T. solium*, but only about one-tenth as large; they are of about the same dimensions as those of *T. saginata*, but much less numerous.

Other characters enumerated by Guyer might be mentioned, in respect to which *T. confusa* occupies an intermediate position between *T. saginata* and *T. solium*. How widely the new species occurs is, of course, unknown. It may be that the existence of this intermediate species has merely been overlooked heretofore; another possibility suggests itself — can it be that these apparently rare specimens are hybrids between *T. solium* and *T. saginata*, a thing, to be sure, unheard of heretofore, but not for that reason impossible. W. E. C.

Zoological Results of Dr. Willey's Collecting Trip.[1] — Naturalists have been looking with eager anticipation for the publication of the results of the three years' expedition of Dr. A. Willey to New Britain, New Guinea, and the Loyalty Islands. These results have now begun to appear in book form. Part I has just come to hand. This volume comprises papers by Dr. Willey on the Anatomy and Development of Peripatus Novæ-britanniæ; P. Mayer, Metaprotella Sandallensis, *n.sp.* [Caprellidæ]; Boulanger, on a Little-known Sea Snake from the South Pacific: Pocock, Report on the Centipedes and Millipedes; Sharp, Account of the Phasmidæ, with notes on the eggs; Pocock, Scorpions, Pedipalpi, and Spiders.

The account of the new Peripatus is perhaps of most general interest. It represents a new-subgenus, Paraperipatus. The ova are small and without yolk, and many embryos, in all stages of development, may occur in the uteri of one female. The embryos lying in the uteri receive nourishment from the mother and are born in a more complete condition than in any other species of the genus. This paper is accompanied by four plates.

The Common Toad. — It is a matter of congratulation for teachers of nature studies in our schools when a well-trained scientific worker will turn aside to put in an attractive form the story of a common object. This has been done by Prof. S. H. Gage, who in a pamphlet of some twenty pages has given an account of the life history and habits of the common toad.[2] The treatment of the subject, while

[1] Zoological Results, based on material from New Britain, New Guinea, Loyalty Islands, and elsewhere, collected during the years 1895, 1896, and 1897, by Arthur Willey, D.Sc., London. Pt. i, Cambridge, 1898. 11 pls. The Macmillan Company.

[2] Gage, S. H. The Life History of the Toad, *Teacher's Leaflets*, prepared by the College of Agriculture, Cornell Univ. (April, 1898), No. 9.

thoroughly accurate, is noteworthy for its simplicity and straightforwardness, and Professor Gage has shown himself a master in this form of composition. Not a little of the success of the pamphlet is due to the illustrations, which show a happy blending of informational and decorative purposes. In one respect only does the text seem open to some criticism ; the occasional endowment of the toad with semi-human faculties, while adding to the interest of the composition, is perhaps not wholly consistent with nature. The account is full of suggestions for outdoor studies, and concludes with some appropriate book references for the teacher. G. H. P.

Eyes of Annelids. — The histological structure of the eyes of the free-living marine annelids has been investigated by K. E. Schreiner.[1] In Nereis the retina consisted of pigmented retinal cells and non-nervous supporting cells. In all other annelids examined, Eunice, Hesione, Lepidonotus, Phyllodoce, Asterope, and Alciope, only pigmented retinal cells were observed. This difference the author believes to be of fundamental importance, and he therefore separates Nereis, so far as its eyes are concerned, from the other annelids. The remaining forms then make a natural series, from those with open cup-like eyes, such as are found in Eunice, to the closed vesicular eyes of Alciope. G. H. P.

Mesoplodon on the Norway Coast. — J. A. Grieg records the capture in August, 1895, on the Norway coast, of two specimens of the whale, *Mesoplodon bidens* Sow.[2] Previously this species had been noted in Scandinavian waters only five times. Of one specimen, presumably a female, only the skeleton was obtained ; the other, a male, received with the flesh on it, was photographed, and a cast made of it. Both specimens were mounted as skeletons for the Bergen Museum, and Grieg's paper is occupied largely with an account of their osteology. It is reported that when the first one, which was found stranded alive, was shot, it made a noise like a calf being butchered. G. H. P.

Variation in Actinians. — J. A. Clubb has undertaken to examine large numbers of the common species of actinians found in the neighborhood of Liverpool, England, with the intention of ascertain-

[1] Schreiner, K. E. Histologische Studien über die Augen der freilebenden marinen Borstenwürmer, *Bergens Museums Aarbog*, 1897, No. 8.

[2] Grieg, J. A. Mesoplodon bidens Sow, *Bergens Museums Aarbog*, 1897, No. 5.

ing the extent to which they are open to structural variations.[1] The first species reported on is *Actinia equina*, of which 165 specimens were examined. In all these the mesenteries were hexamerous in arrangement, but in seven, or 4.24 per cent, abnormalities were noted in the siphonoglyphs. Four of these seven specimens had one siphonoglyph each ; one had three, and two had two, which, however, were not opposite each other. In all cases the siphonoglyphs were accompanied with directive mesenteries, and no such mesenteries were found except associated with siphonoglyphs. This enumeration shows that *A. equina* is far more stable as a species than other actinians, such as *Metridium marginatum*, in which the abnormal individuals far outnumber the normal ones.

G. H. P.

Dorsal Organs of Arthropods. — Nussbaum and Schreiber[2] conclude that the various structures in the arthropods, — some median and others paired, — known as dorsal organs, are cænogenetic in character, and have as their function the reduction of the vitellocyte layer, while in a few cases it produces a secretion which in Idotea fixes the embryo to the chorion. In other cases the secretion may serve as a protective layer between chorion and embryo.

Zoological Notes. — We have already referred to the failure of the Senff expedition to northern Africa in its endeavor to obtain materials illustrating the embryology of the Dipnoan Protopterus. We learn, however, that the University of Cambridge has received a large series of embryos of the closely allied Lepidosiren from South America, which, we hope, may give us a better knowledge of this interesting group.

The United States Fish Commission has been actively engaged in the study of the tile fish, and this year finds them very abundant and extending over a larger range than was known before.

The discovery of a fourth specimen of the rare rail, *Notorius hochstetteri*, in New Zealand, is announced.

Göppert concludes, as the result of detailed studies on the laryngeal apparatus of the Amphibia,[3] that the whole laryngeo-tracheal skeleton — that is the arytenoids and the cricoids, as well as the

[1] Clubb, J. A. The Mesenteries and Œsophageal Grooves of Actinia equina Linn. *Trans. Liverpool Biol. Soc.*, vol. xii, pp. 300–311.

[2] *Biol. Centralblatt*, Bd. xviii (1898), p. 736.

[3] *Morph. Jahr.*, Bd. xxvi (1898), p. 282.

tracheal and bronchial rings — arise from the seventh visceral (fifth branchial) arch, and that the laryngeal muscles arise from the musculature of the same arch. In the same number of the journal, Hochstetter continues his researches on the blood vessels, this time discussing the arteries of the alimentary canal. Bolk describes an abnormal condition in the shorter head of the biceps femoris muscle of the orang, and discusses its bearings upon the morphology of this muscle. Maurer describes the vacuolization of the epidermis of the anura at the time of metamorphosis, while Gegenbaur has some remarks upon anatomical nomenclature, urging the retention of personal names as a guide to the history of the subject, as well as considering the terminations -ideus or -oides.

BOTANY.

A New Text-book on Fossil Plants.[1] — Of late years an increasing interest in the study of plant-fossils has been developed among botanists, especially with reference to the bearing of these fossil remains upon the origin of existing plants.

The great importance of a thorough knowledge of fossil plants in the study of the evolution of plant forms is sufficiently obvious; but, unfortunately, much of the descriptive work upon fossil plants has been done by men who were not botanists, and whose knowledge of living plants was of the slightest. This fact has helped to discredit much of the work in paleobotany, and a great deal of really important work has not, perhaps, received the attention it deserved. There is at present almost hopeless confusion in the nomenclature of fossil plants, names having frequently been given to unrecognizable fragments of more than dubious autonomy, and often enough shown later not to be plant remains at all. It is most encouraging then when we find trained botanists entering the field; men who are really competent to interpret the specimens with which they have to deal, and not so much interested in adding to the already overgrown list of doubtful fragments as in doing something to throw light upon the real affinities of the forms already described.

Professor Seward's thorough training, both as botanist and geologist, has prepared him admirably for the task he has set himself, and it must be admitted that he has acquitted himself in a most satis-

[1] Seward, A. C., M.A., F.R.S. *Fossil Plants*, vol. i. Cambridge, University Press, 1898.

factory manner. Both the botanist and geologist will find his work of the greatest value — quite indispensable, indeed, in a study of the fossil flora of the earth.

The rich collections of the British Museum, as well as other great collections in Britain and elsewhere, have furnished the author with a great mass of valuable materials, of which he has made most excellent use.

The first three chapters of the present volume comprise, first, a comprehensive sketch of the development of the science of paleobotany; a chapter on the relation of paleobotany to botany and geology; and an extremely clear account of the succession and limits of the principal geological periods. A most interesting chapter follows, dealing in a striking way with the factors concerned in the preservation of plant remains. As plants are for the most part destitute of skeletal tissues, except wood, it is not surprising that they have left relatively few remains when compared with animals. This is especially the case among the lower non-vascular plants. Many interesting illustrations are given to show how the process of fossilization is going on at the present day. One of the most striking is the description of the great masses, or rafts of vegetation, drifted out to sea from the mouths of large rivers, like the Mississippi or Amazon. The harder and less perishable structures, like the trunks of trees, and hard seeds or fruits, finally sink to the bottom of the sea, often hundreds of miles away from their original habitat, and, gradually buried in the sediment at the bottom, may in future ages appear as fossils, mingled with various marine forms. It is probable that the occurrence of terrestrial, or fresh-water organisms in fossil beds of marine origin is to be accounted for in this manner.

It is rather startling to learn that not only may such structures as the cuticle and cell walls of the epidermis be preserved, but that delicate parenchyma cells with traces of the contained protoplasm and nuclei can occasionally be recognized in a fossil condition! The most perfect fossils are those in which there has been an infiltration of silicious matter, and such petrifactions often have the tissues so perfectly preserved that microscopic sections reveal most beautifully the details of the cellular structure. It is the study of such sections that has done more, perhaps, than anything else to explain the real affinities of the plants in question.

Chapter V deals with the difficulties and sources of error encountered in dealing with fossil plant remains, and shows how cautious

the investigator must be in drawing conclusions from mere impressions, no matter how clear they may be. The extraordinary external resemblances between unrelated forms is shown by a number of illustrations; *e.g.*, Equisetum, Casuarina, Ephedra.

The second part of the volume is systematic and deals with the fossil forms from the lowest plants, Bacteria and Schizophyceæ, and other simple unicellular organisms, and comprises the Algæ, Fungi, Mosses, and part of the Pteridophytes.

Among the lowest forms, as might be expected, fossils are comparatively few, and often of more than doubtful authenticity. Nevertheless, there are evidences of the existence of Bacteria and blue-green Algæ in very old formations, although in most cases these evidences consist rather in the results of their growth than in the presence of the organisms themselves, *e.g.*, calcareous nodules formed by Cyanophyceæ, partially decomposed tissues attacked by Bacteria.

Among the Algæ, only such forms as have a calcareous or silicious skeleton have left fossils whose nature is unmistakable. Professor Seward is very cautious about accepting the validity of many such doubtful forms as the so-called "Fucoids," for instance, which are merely impressions of extremely doubtful character. There are, however, very perfect fossils whose algal nature is perfectly evident. Of these, the Diatoms, the calcareous Coralline Algæ or "Nullipores," and the calcareous green Algæ, belonging to the Characeæ and Siphoneæ, are the best known. The latter group and the Corallines have played an important part in the formation of certain limestones. As at the present day, in the warmer seas, they grew about the coral reefs which owe their growth to no inconsiderable degree to the activity of these calcareous Algæ. According to Professor Seward, there are reliable evidences of the existence of Corallines as far back as the upper Cambrian and lower Silurian, and the calcareous Siphoneæ were evidently abundant in the ancient seas. The Diatoms are a much more recent development, and no certain evidences of their existence have been found below the secondary formations.

The true Phæophyceæ, or brown Algæ, never develop a calcareous or silicious skeleton, and have left practically no fossil remains that are certainly recognizable. Many casts from the older formations have been attributed to Algæ of this group, but these casts are usually of very doubtful origin. The most probable remains of Phæophyceæ belong to the genus Nematophycus, from Devonian and Silurian deposits. This genus shows some evidences of a structure compara-

ble to that of the existing giant kelps, like Lessonia or Macrocystis. Remains of Fungi and Mosses are too scanty and imperfect to throw much light upon the geological history of these two groups of plants.

Space will not permit of more than a reference to the rest of the contents of the volume in hand. Of the Pteridophytes, the Equisetineæ are fully and clearly treated, and the volume concludes with an account of the genus Sphenophyllum, which is considered to be the type of a class, Sphenophyllales, coördinate with the other phyla of the Pteridophytes. A full bibliography and index complete the volume.

The work may be recommended unqualifiedly as a thoroughly reliable and clear presentation of a most interesting and important subject. It is to be hoped that the second volume may be soon before us. DOUGLAS HOUGHTON CAMPBELL.

Illustrierte Flora von Deutschland. — The eighteenth revised edition of Garcke's German flora is now at hand. This admirable work is too well known to need description. The new edition, although embodying many minor corrections in keys, plant ranges, etc., maintains in all more important matters the same form as the edition of 1895. Like this, it is illustrated by some 760 block cuts, scattered in the text. These figures, although in some cases a trifle stiff and wooden in general appearance, are very clear and accurate in detail. The work is more than ordinarily interesting to Americans from a sort of parallelism with Dr. Gray's well-known *Manual of Botany*. Both were first issued in 1848, and have alike, in successive editions, received repeated and painstaking revision by their authors. Both follow the De Candollean arrangement of families and what is now regarded as a conservative nomenclature. Both italicize distinctive characters, scatter their specific keys through the text, cite authorities and important synonyms, but omit all bibliography. Both have been exceptionally useful books and still enjoy wide popularity.

The German work describes 718 genera and 2614 species of vascular plants. Its introductory key, still based upon the classes and orders of Linnæus, seems something of an anachronism, but is skillfully managed and certainly lucid. A feature of questionable taste is the use of authorities after vernacular family names. Such expressions as "Campanulaceen Juss.," "Compositen Adans.," and the like, are, it is true, not seriously misleading, yet they are, strictly speaking, inaccurate and therefore to be avoided. B. L. R.

Moore's Bacteriology.[1] — This little book was originally prepared in the form of mimeograph sheets for the use of students in the bacteriological laboratory at Cornell University, and its statements have consequently been tried in the fires of actual use. Now that these directions have been printed in a simple and inexpensive form, it is to be hoped that they will find their way into many schools and laboratories where bacteriology is studied. No claim is made to completeness or infallibility, but at the same time it would be difficult to find anywhere in the world, in the same number of pages, as many important and useful suggestions. Dr. Moore's courses in bacteriology in the veterinary school at Cornell are among the very best in the country, and this book is to be welcomed as an extension of the influence of a conscientious teacher who is at the same time a competent investigator. The book contains 89 pages, beginning with the cleaning of glassware and ending with the bacteriological examination of water. It is arranged in 59 chapters, designed for as many separate laboratory exercises. Migula's system of classification is adopted. The occasional imperfections and omissions will no doubt be rectified in subsequent editions, of which we trust there may be many.

ERWIN F. SMITH.

Monographie der Myristicaceen.[2] — In few even of the tropical groups of plants have generic lines been so poorly understood as in the Myristicaceæ, the nutmeg family. From time to time attempts have been made to separate from the large and evidently heterogeneous Myristica various independent genera, but hitherto the herbarium materials of the whole family have been so fragmentary, and the difficulty of constructing from them a satisfactory group of genera so great, that even in 1880 it still seemed best to Bentham and Hooker to treat the whole family as a single complex genus.

For some years Dr. Otto Warburg, of the Botanical Museum in Berlin, has been engaged on an exhaustive revision of this confused group, and his completed work, now before us, shows that the task could not have fallen into better hands. The monograph (filling a thick folio of some 680 pages) is of a kind that only Germans have patience to prepare. A liberal space has been allotted to the treat-

[1] *Laboratory Directions for Beginners in Bacteriology.* By Veranus A. Moore, B.S., M.D., Professor of Comparative Pathology and Bacteriology and of Meat Inspection, N. Y. State Veterinary College, Cornell University, Ithaca, N. Y. Published by the author, 1898.

[2] Warburg, O. *Abh. Leop.-Carol. Akad.* Bd. lxviii. Halle, 1897.

ment of the history, affinities, anatomy, morphology, biology, distribution, paleontology, and economic significance of the Myristicaceæ, yet all this is introductory to the elaborate systematic subdivision of the family. Fifteen genera are recognized, of which no less than eleven have been proposed by Dr. Warburg himself. Of these genera, five are American, six African, and four Asiatic. Probably no feature of the work, not even its full descriptions and excellent plates, will add more to its systematic value than the detailed citation of ranges and herbarium specimens.

Like some other compendious German monographs, Dr. Warburg's work is provided with several special indices, which, for convenience, might much better have been united into a general one.

B. L. R.

List of Mosses of New Brunswick.[1] — In their recently published catalogue of New Brunswick mosses, Messrs. Moser and Hay enumerate 245 numbered species and varieties, and thirteen unnumbered varieties, with localities appended. About fifty stations are recorded which are not found in Macoun's *Catalogue*. Fifteen "new species" and one "new variety" (six of which are briefly characterized) are included, all of which were described in 1892,[2] or (in three instances) prior to that date.[3] A noticeable lack of uniformity is caused by the omission of the author's name after more than a score of the specific and a majority of the varietal names. Every page contains a few minor typographical errors in scientific names. But even with these defects the list will be found useful.

J. F. C.

The Orchids of the Sikkim-Himalaya. — The most sumptuous publications of any botanical garden in the world, not even excepting that at Buitenzorg, are those which emanate from the Royal Botanic Garden at Calcutta. The eighth volume of the *Annals* of this garden,[4] consisting of four parts, put up in two thick portfolios, is devoted to an elaborate monograph of the orchids of the Himalayan range, which for completeness and elaborateness of execution is only to be compared with Dr. King's *Anonaceæ of British India*, Gamble's

[1] Compiled by John Moser and edited by G. U. Hay. *Bulletin xvi*, Nat. Hist. Soc., N. B. (pp. 23–31). St. John, N. B., 1898. (Price 50 cents.)

[2] Macoun. *Catalogue of Canadian Plants*, Part vi. (Musci)

[3] Ottawa *Naturalist*, vol. iv, and Lesq. and James's *Manual*.

[4] King, G. and Pantling, R. The Orchids of the Sikkim-Himalaya, *Annals of the Royal Botanic Garden, Calcutta*, vol. viii. iv + 342 pp., 448 plates. Calcutta, 1898. Sq. F4. £6–6, plain; £9–9, half-colored.

Bambuseæ of British India, or, to make a long story short, the other members of this remarkable series. Like its predecessors, the eighth volume is well printed, and in a portion of the edition certain parts of each plate are colored so as to represent the natural tints of the flowers.

T.

Dr. J. W. Harshberger, who made an incursion into Mexico in 1896, has recently published a paper entitled "Botanical Observations on the Mexican Flora, especially on the Flora of the Valley of Mexico,"[1] in which he gives an annotated list of the plants found in the latter region, prefaced by a short diary and a topographic account of the district. Additional lists are also given for Orizaba and Cordoba. Unfortunately for ordinary use, the catalogue is broken up into a number of separate lists, classified according to habitat, instead of being consolidated into a single enumeration with the ecological information arranged under the several species.

T.

Botanical Notes. — *Apios Priceana* is the name given by Dr. Robinson, in the *Botanical Gazette* for June, to a very interesting plant from Kentucky, discovered by Miss Sadie F. Price, who appears to be making a thorough study of the flora about Bowling Green.

Curtis's Botanical Magazine for October contains a plate of *Amelanchier Canadensis* var. *oblongifolia*, which is sometimes treated by botanists as a distinct species.

The Nepenthes of Australia are discussed by F. M. Bailey in the *Journal of the Royal Horticultural Society* for October. Five cuts, illustrating the leaves of as many species, are given.

A fifth contribution to the knowledge of Melocacti, by the late Professor Suringar, appears in Vol. vi of the *Verslagen* of the Royal Academy of Sciences at Amsterdam.

Opuntia Galapageia is well figured in its natural surroundings in the *Gardeners' Chronicle* of October 8, in connection with a short note on the cacti of the Galapagos Islands, by Mr. Hemsley.

"The Date Palm" is the subject of *Bulletin No. 29* of the Arizona Agricultural Experiment Station, by Professor Toumey, who concludes that southern Arizona has the requisite climate and soil conditions necessary for a profitable cultivation of this tree for the production of fruit on a commercial scale.

[1] *Proc. Acad. Nat. Sci.*, Philadelphia, August, 1898.

A comparative histological study of *Veratrum viride* and *V. album* is published by R. H. Denniston in No. 3 of the current volume of *Pharmaceutical Archives.*

"Economic Grasses" is the title of *Bulletin No. 14* of the Division of Agrostology of the United States Department of Agriculture. The paper is virtually an abbreviated edition of *Bulletin No. 3* of the same Division, and, like that, is well illustrated, a number of good half-tone plates being introduced into the present edition. Professor Scribner appears as its author.

Nos. 9 and 10 of the first Abtheilung of the *Botanische Zeitung* for 1898 contain a study of the male prothallus of Hydropterides, by Belajeff.

In the *Jahrbücher für Wissenschaftliche Botanik*, Vol. xxxii, Heft 3, Heinricher publishes a second paper on "Die grünen Halbschmarotzer," dealing with the genera Euphrasia, Alectorolophus, and Odontites.

Rimbach contributes an extensive illustrated article on the growth of rhizomes to a characteristic depth in the soil, to Fünfstücks *Beiträge zur Wissenschaftlichen Botanik*, Vol. iii, Abteilung 1, in continuation of an article in the preceding volume of the same publication on contractile roots and their action.

The possible fiber industries of the United States is the subject of an illustrated article, by C. R. Dodge, in *Popular Science Monthly* for November.

The *Journal of the Royal Horticultural Society* for October devotes something over forty pages to papers by Mr. Burbidge on perfumes, and the plants which afford them, an important part of the collection being a list of books on perfumes.

Twelve of Idaho's worst weeds are described and figured by Professor Henderson in *Bulletin No. 14* of the Agricultural Experiment Station of the University of Idaho. The article is prefaced by an account of the source and mode of dispersal of weeds.

Instructive little handbooks by Dr. Niederlein on the Republic of Guatemala, the State of Nicaragua, and the Republic of Costa Rica have recently been issued by the Philadelphia Commercial Museum. Their scope, while ultimately economic, includes topography, geology, soil, flora, and fauna, so they should be of value to scientific trav-

elers as well as to persons directly interested in the development of the countries of which they treat.

The *Botanical Gazette* for October contains a sketch, by Mr. Norton, of the life of the late Joseph F. Joor, a botanist of Texas and Louisiana.

PETROGRAPHY.

The Lavas of Two Volcanoes in the Eifel.—The lavas of the small volcanoes Hochsimmer and Bellerberg, near Mayen, in the Eifel, were thought to be similar in composition by the earlier geologists. Schottler,[1] however, reports the Hochsimmer lava to be a porphyritic leucitite with phenocrysts of augite, biotite, olivine, and hauyne in a groundmass composed of leucite, augite, and glass. The Bellerberg lavas are augite-andesites, with phenocrysts of augite and biotite in a groundmass composed of augite, plagioclase, a little leucite, and glass. Olivine, hauyne, and quartz are also present in some specimens as porphyritic crystals. The rock approaches in character the tephrites. Large numbers of inclusions are imbedded in the lavas. Some of them are unquestionably endogenous, while others are certainly exogenous. A few consisting of single minerals exhibit no evidence as to their origin. All have been deeply corroded by the action of the enclosing magma. The isolated minerals represented among the foreign inclusions are: hauyne, zircon, corundum, garnet, olivine, feldspar, and quartz. The rock inclusions are fragments of graywackes, slates, quartz-feldspar-aggregates, cordierite and sillimanite-bearing schists, hornblende-schists and biotite-schists, augite-feldspar-aggregates, limestone, and sanidine-aggregates. The limestone inclusions often contain cavities, and in these crystals of chalcomorphite, ettringite, and quartz have been deposited. The action of the magma on the limestone is seen in the formation of feldspars, augite, and glass in the rock surrounding the inclusion, and in the production of wollastonite, quartz, and nepheline in the inclusion itself.

A Sedimentary Granite.— Professor Winchell[2] points out the fact that the oldest rocks in Minnesota are the archean greenstones. The granites which intrude these are believed to be fused sediments.

[1] *Neues Jahrb. f. Min.* etc., Beil. Bd. xi, p. 554.

[2] *Amer. Geologist*, vol. xxii, p. 299.

On the shores of Kekequabic Lake is an augite-granite so closely associated with greenstone-conglomerates (probably tuffs) or greenstone-schists that gradations between the two are thought to have been discovered. Grant, who has studied the same granite, considers it a normal intrusive.

Brush's Manual of Determinative Mineralogy[1] appears in an entirely new edition, — the fifteenth. The book has been completely rewritten by Penfield since the thirteenth edition was published, only the plan of the original having been retained. The contents are entirely new. The present edition differs from its immediate predecessor in the addition of a chapter on the physical properties of minerals and in an entirely new set of analytical tables.

The introductory portion of the volume occupies 244 pages, the tables 58 double pages, and the indices 12 pages. In the index to minerals are found the names of 1015 kinds, a fact that indicates the thoroughness with which the tables cover the field they are intended to cover. There are very few minerals known, except the rarest, that may not easily be identified by following the scheme of analysis indicated by the author.

The chapter on physical properties is devoted mainly to an outline discussion of the principles of crystallography based on the theory of thirty-two classes of symmetry. It treats also very briefly of cohesion, luster, color, and density. All the explanations are clear and the descriptions lucid, so that the student need not have the least difficulty in following them.

There is no question that Professor Penfield's book will rapidly achieve the highest favor among teaching mineralogists. Were it not for the fact that it is somewhat expensive for a book of its kind, it would no doubt soon nearly supplant all other manuals of a similar character among English-speaking students. W. S. B.

Notes. — The interesting group of lava flows for which the name of latite has been proposed by Ransome[2] is carefully described in a recent Bulletin of the Survey. These rocks have already been referred to in those notes. From the discussion of the relations of the effusives intermediate in character between the trachytes and

[1] *Manual of Determinative Mineralogy, with an Introduction on Blowpipe Analysis*, by George J. Brush. Revised and enlarged, with entirely new tables for the identification of minerals, by Samuel L. Penfield. Fifteenth edition. x + 312 pp., 375 figs. New York, Wiley & Sons, 1898. $3.50.

[2] *Bull. U. S. Geol. Survey*, No. 89, Washington, 1898.

the andesites to one another it appears that the author proposes the name to cover a group of different rock types, and not as the name of any special type. The latites embrace all the effusive forms of the monzonite magmas.

Derby[1] has examined a large number of specimens of kaoline, pegmatites, and muscovitic granites and gneisses from different parts of Europe with respect to their rare components. In many of them he has discovered xenotime and monazite.

Watson[2] has studied the mesozoic diabases near Chatham, Va., and their decomposition products, following the lines laid down by Merrill in the reports of his investigations on weathering. The changes undergone by an olivine diabase in weathering are shown by the first three of the following lines of figures. The fourth line gives the percentage of loss of each constituent in passing from the fresh to the decomposed condition.

	SiO_2	Al_2O_3	$Fe_2O_3.FeO$	CaO	MgO	Na_2O	K_2O	H_2O		Total.
Fresh rock	45.73	13.48	11.60	9.92	15.40	3.24	.47	.94	=	100.78
Weathered rock	47.87	14.43	11.55	10.45	10.58	3.47	.61	1.82	=	100.78
Decomposed rock	37.09	13.19	35.69	.41	.57	1.75	.33	11.83	=	100.86
	73.64	68.19	0.00	98.68	98.81	82.46	77.31			

The total loss is 70.31 per cent of the original, *i.e.* fresh, rock.

Nitze and Wilkens[3] have given us an excellent account of the methods employed in the gold mines of North Carolina and the adjacent southern states, and good descriptions of the mines themselves. Their report appears as a Bulletin of the North Carolina Survey.

Another Bulletin of this energetic and progressive survey is entitled "Clay Deposits and Clay Industry in North Carolina." It is by Ries,[4] and is one of the best reports on clay that has appeared in this country. It contains the records of numerous analyses, both chemical and mechanical, and a fine description of the special characteristics of clays of economic value.

One of the alterative products of the paleopicrite[5] of Medenbach, near Herborn, is sahlite. It occurs as acicular crystals imbedded in serpentinized olivine and as fringes of needles bordering brown augite, especially on that side of the augite facing olivine grains.

A marekanite obsidian from Corinto, Nicaragua, is mentioned by

[1] *Mineralogical Magazine*, vol. xi, p. 304.

[2] *Amer. Geol.*, vol. xxii (1898), p. 85.

[3] Nitze, H. B. C., and Wilkins, H. A. J. Gold Mining in North Carolina and Adjacent Appalachian Regions, *Bull. No. 10*, N. C. Geol. Survey, 1897.

[4] *Bull. No. 13*, N. C. Geol. Survey, 1897.

[5] Brauns, R. *Neues Jahrb. f. Min.* etc., vol. ii (1898), p. 79.

Peterson[1] as being represented by specimens in the Natural History Museum at Hamburg. An analysis gave:

SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	K_2O	Na_2O	H_2O	Total.
76.68	14.49	1.09	tr.	.84	1.53	1.20	3.92	.36 =	100.11

The rock is a colorless glass containing numerous globulites, etc., arranged in flowage lines.

GEOGRAPHY.

Map of Alaska. — There has recently been published, by the United States Geological Survey, a *Map of Alaska*, on a scale of 1 : 3,600,000. The map is printed in colors, showing the location of gold and coal, and the distribution of principal gold-bearing series. There are also inserted a map of the principal trails to the headwaters of the Yukon and a map of the Klondike Gold Region, both on a scale of 1 : 1,447,000. A descriptive text contains sketches of the geography and geology of Alaska, with an account of the gold fields and the routes to them.

The German Deep-Sea Expedition. — We copy from the *Geographical Journal* the following account of this expedition up to last November:

"The German Deep-Sea Expedition of 1898 started under the most favorable auspices as regards the vessel itself, the arrangements made to adapt it for carrying on deep-sea investigations, and for the accommodation of the members of the scientific staff, and the apparatus and appliances to be used in carrying on the work, which are of the latest and most approved description. The 'Valdivia' is about the same size as H. M. S. 'Challenger'; she steams 10 to 11 knots; the bacteriological, chemical, and biological laboratories and workrooms are commodious and well fitted up; the cabins occupied by the scientific staff are large and handsome, the principal cabin containing a splendid scientific library, including a complete set of the *Challenger Reports*, and there is ample accommodation for storing the marine and other collections made throughout the cruise.

"Prof. Carl Chun, professor of zoology in the University of Leipzig, the originator and leader of the expedition, is accompanied by a staff of eleven scientific men, to assist him in carrying on the various

[1] Brauns, R. *Neues Jahrb. f. Min.* etc., vol. ii (1888), p. 156.

observations, as shown in the following complete list of the members of the expedition:

"A. *Official Members.* — Prof. Carl Chun, leader; Prof. W. Schimper (Bonn), botanist; Dr. Karl Apstein (Kiel), zoologist; Dr. Ernst Vanhöffen (Kiel), zoologist; Dr. Fritz Braem (Breslau), zoologist; Dr. Gerhard Schott (Hamburg Seewarte), oceanographer; Dr. Paul F. Schmidt (Leipzig), chemist; Officer Sachse (Hamburg-American Line), navigator; Dr. M. Bachmann (Breslau), physician and bacteriologist.

"B. *Non-Official Members.* — Dr. August Brauer (Marburg), zoologist; Dr. Otto L. zur Strassen (Leipzig), zoologist; Herr Fr. Winter (Frankfort a/M.), scientific draughtsman and photographer.

"Each member of the scientific staff receives eight marks per day from the government, and their lives are insured for 30,000 marks each in case of death.

"The 'Valdivia' sailed from Hamburg on August 1 last, and is expected to be absent about nine months. The route to be followed may be divided into three portions: (1) From Hamburg round the north of Scotland to the Canary Islands, past the Cape Verde Islands, touching at the mouths of the Kameruns and Congo Rivers and Walfisch Bay, to Cape Town; (2) from the Cape of Good Hope, the Agulhas Bank will be examined, then southwards past Prince Edward Island to the edge of the antarctic ice, returning northwards through the center of the Indian Ocean to the Cocos and Christmas Islands, and thence to Padang in Sumatra; (3) from Padang to Ceylon, thence calling at the Chagos, Seychelles, and Amirante group of islands to Zanzibar, returning home by the way of Sokotra, the Red Sea, Suez Canal, and the Mediterranean.

"On August 4 all the members of the expedition which had sailed to Edinburgh visited the 'Challenger' office there and examined the specimens of deep-sea deposits, etc., brought home by the 'Challenger.' In the evening, after being entertained at dinner by Sir John Murray, the expedition sailed for the Faröe Channel and the Canary Islands. Preliminary accounts of the first dredgings, trawlings, and temperature observations in the North Atlantic had been received in October, the expedition having safely arrived at the Cape Verde Islands. The expedition was to have reached Cape Town in November."

SCIENTIFIC NEWS.

Dr. C. W. Hitchcock, of Dartmouth, is spending the year in making geological explorations in the Hawaiian Islands.

Asa Van Wormer, a wealthy merchant of Cincinnati, has given $56,000 to the University of Cincinnati, to be used for the erection of a fireproof library.

Mr. S. W. Loper, curator of the museum of Wesleyan University, has returned from a very successful collecting trip of seven weeks in the Rocky Mountains. From the Tertiary Eocene beds at Fossil, Wyoming, he obtained 400 specimens of fossil fishes, insects, and plants. In Utah and Colorado he also collected large numbers of valuable fossils. All told he secured about 1300 specimens.

On the twenty-second of October, Toland Medical College was formally transferred with appropriate ceremony to the keeping of the board of regents of the University of California. Toland Medical College was founded in 1863 by Dr. Hugh Huger Toland, who gave $75,000 for that purpose. Eventually Dr. Toland presented the college to the University of California, but until October it was still known as Toland College.

The late Franklin Story Conant, who died of yellow fever contracted in Jamaica, in the summer of 1897, was a graduate of Williams College, in the class of 1893. His classmates have established a prize of $25 annual value, open to students of Williams College, and available towards defraying the expenses of the winner at the Woods Holl Laboratory.

The city of Hamburg has established a station for plant investigations, under the directorship of Dr. Carl Brick. Dr. Ludwig Reh, for some time assistant of Dr. Field, in his bibliographical institute, goes to the new station as zoologist.

Dr. David D. Cunningham, professor of physiology in the Calcutta Medical School, has resigned and has returned to England.

Prof. W. Adolf Bastian, director of the ethnological museum in Berlin, has returned from a trip of two and a half years in Farther India.

James Ingraham Peck, assistant professor of biology in Williams College, died of pneumonia, Nov. 4, 1898, aged thirty-five. He was born at Seneca Castle, New York, graduated at Williams in 1887, re-

mained there a year, and then went to Johns Hopkins for graduate studies. After receiving the degree of Ph.D from the latter institution, he returned to Williams, as assistant in biology, in 1892, and two years later was made assistant professor. During recent years he has carried almost the entire instruction at Williams, and during the summer has acted as assistant director of the Marine Biological Laboratory at Woods Holl. His published papers are upon the variations of the spinal nerves in different varieties of pigeons, the anatomy and histology of pteropods, and upon the plankton food supply of fishes.

Among recent exploring expeditions we notice the following : An English Antarctic expedition, under the patronage of Sir George Newnes, with Borchgrevinck as leader ; Louis Bernacchi, of the Melbourne Observatory, as meteorologist ; Nicolai Hansen and Hugh B. Evans as zoologists and collectors. The government of New South Wales has sent out a deep-sea expedition under the charge of Edgar R. Waite, of the Australian Museum. Its explorations will be confined to the adjacent regions. The Dutch government has assisted in a natural history exploration of the East Indian Archipelago, under the charge of Max C. W. Weber, the professor of zoology in the University of Amsterdam. Frau Weber accompanies him as botanist, while Dr. Jan Versluijs, of Amsterdam, and Herr H. F. Nierstrasz, of Utrecht, will assist upon the zoological side. Prof. P. Knuth, of Kiel, goes round the world on a scientific trip. He expects to spend some time in Buitenzorg, Java. Prof. K. Goebel, of Munich, takes a botanical trip to Australia and New Zealand.

The association of Deutscher Naturforscher und Aertze will meet next September in Munich. Over two thousand members were present at the meeting at Düsseldorf in 1898.

In recent years, as in times past, the University of Oxford has ranked far behind the other large English universities in scientific lines. At Cambridge investigators have been numerous, and they have had abundant facilities for their work, while at Oxford the students were few and the accommodations meager. Oxford loses still further in the recent appointment of her prominent zoologist, Prof. E. Ray Lankester, who goes to London as director of the Natural History Museum at South Kensington.

Charles William Andrews, of the geological section of the British Museum, has returned to London after a fifteen months' trip to Christmas Island.

Recent appointments: Mr. C. A. Barber, government botanist at Madras, India. — Dr. Friedrich Becke, of Prague, professor of mineralogy in the University of Vienna. — Dr. Friedrich Blochmann, of Rostock, professor of zoology in the University of Tübingen. — Prof. Oskar Brefeld, of Münster, professor of botany in the University of Breslau, as successor to Cohn. — Dr. Steven Crowe, tutor in bacteriology in the College of Physicians and Surgeons in San Francisco. — Dr. Frederick E. Clements, lecturer in botany in the University of Nebraska. — Dr. Franz W. Dafert, of Sao Paulo, Brazil, director of the Agricultural Experiment Station in Vienna. — Dr. O. V. Darbishire, lecturer and demonstrator in botany in Owens College, Manchester. — Dr. Dieudonné, privat-docent for bacteriology in the University of Würzburg. — Dr. Hermann Dingler, professor of botany in the forestry station at Aschaffenburg. — Mr. Frederick O. Grover, professor of botany in Oberlin College. — G. T. Hastings, assistant in botany in Cornell University. — G. M. Holman, assistant in biology in the Massachusetts Institute of Technology. — Dr. Honl, privat-docent for bacteriology in the Bohemian University in Prague. — Dr. Hans Hausrath, extraordinary professor of forestry in the Karlsruhe Technical School. — Dr. J. Jablonowski, assistant in anthropology in the Dresden Museum. — Dr. Friedrich Katzer, of the museum at Para, Brazil, geologist of the museum at Sarajevo, Bosnia. — Dr. Georg Klebs, of Basel, professor of botany in the University of Halle. — Dr. Fr. Kopsch, privat-docent for anatomy in the anatomical-biological institute of the University of Berlin. — Dr. Robert Lauterborn, of Ludwigshafen, privat-docent for botany in the University of Heidelberg. — Dr. Hans Lenk, professor of mineralogy and geology in the University of Erlangen. — Dr. Ritter Lorenz von Liburnau, docent in zoology in the Vienna School of Agriculture. — Prof. Lugui Luciani, rector of the University of Rome. — George Grant McCurdy, instructor in prehistoric anthropology in Yale University. — Dr. Albert Matthews, assistant professor of physiology in the Medical School of Tufts College. — W. A. Merrill, assistant in botany in Cornell University. — Dr. B. Moore, professor of physiology in the Medical School of Yale University. — Dr. D. Morris, of the Kew Gardens, head of a department to direct the practical applications of botany in the West Indies. — Dr. Lubomir Niederle, professor of archæology and ethnology in the Bohemian University of Prague. — Dr. E. S. Pillsbury, tutor in bacteriology in the College of Physicians and Surgeons in San Francisco. — Dr. Philipp Počta, professor of paleontology in the Bohemian University of Prague. — James Pollock,

instructor in botany in the University of Michigan. — Dr. C. H. Richardson, instructor in geology and assistant in chemistry in Dartmouth College. — Dr. Adalár Richter, chief of the botanical section of the Hungarian Museum at Budapesth. — Prof. A. F. W. Schimper, of Bonn, professor of botany in the University of Basel. — Dr. Karl Camillo Schneider, privat-docent for zoology in the University of Vienna. — Dr. Paul Schultz, privat-docent for physiology in the University of Berlin. — Julia W. Snow, instructor in botany in the University of Michigan. — Dr. Ernst Stolley, custodian of geology and mineralogy in the museum at Buenos Ayres. — Dr. F. E. Suess, privat-docent for mineralogy and geology in University of Vienna. — Hamilton Timberlake, instructor in botany in the University of Michigan. — Dr. Josef Velenovsky, professor of botany and phytopaleontology in the Bohemian University of Prague. — Prof. W. Waldeyer, rector of the University of Berlin for the coming year. — C. F. Myers-Ward, lecturer in physiology in University College, Sheffield, England. — Dr. Julius Nikolaus Wagner, of St. Petersburg, professor of zoology in the newly established polytechnic institute at Kieff, Russia. — Dr. Werner, docent in zoology in the University of Vienna. — Dr. Heinrich Ernst Ziegler, of Freiburg, i.B., Ritter professor of phylogeny in the University of Jena. — Dr. Zukal, professor of vegetable pathology in the Vienna Agricultural School.

Recent deaths: Professor Arzruni, professor of mineralogy in the École Polytechnique at Aix. — Lugui Balzan, arachnologist and professor of natural history in the University of Paraguay. — Dr. Evert Julius Bonsdorf, formerly professor of anatomy in the University of Helsingfors, aged 88. — Dr. Vicenzo Diamare, assistant in the Institute of Comparative Anatomy of the University of Naples. — Alfred Hart Everett, ornithologist and student of the fauna of the Sunda Islands, June 18. — Dr. C. G. Gibeli, professor of botany in the University of Turin. — Prof. Karl Wilhelm von Gümbel, of Munich, a well-known geologist, July 18, aged 75. — C. W. A. Hermann, formerly a well-known mineralogist in New York, aged 97. — Dr. B. Kotula, botanist. — E. H. Lonsdale, of the U. S. Geological Survey, at Columbia, Missouri, March 7. — João Maria Moniz, botanist, at Funchal, Madeira Islands, July 11, aged 75. — A. Pomel, director of the School of Sciences and the Geological Survey of Algiers in Oran, Algiers. — Dr. H. Präscholdt, formerly teacher of geology and paleontology in the gymnasium in Meiningen, by suicide in an Austrian prison. — Dr. de Windt, geologist, near Lake Tanganyika, Africa.

PUBLICATIONS RECEIVED.

Books.

ATKINSON, GEORGE FRANCIS. Elementary Botany. H. Holt & Co., 1898. Vol. xxiii, 444 pp. $1.25.

BRUSH, GEORGE J. — Manual of Determinative Mineralogy, with an introduction on Blowpipe Analysis. Revised and enlarged by Samuel L. Penfield. 15th edition. New York, John Wiley & Sons, 1898. 312 pp.

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IN THEIR WIDEST SENSE

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ON THE PROPOSED UNIVERSITY OF THE UNITED STATES AND ITS POSSIBLE RELATIONS TO THE SCIENTIFIC BUREAUS OF THE GOVERNMENT.

WILLIAM HEALEY DALL.

For some years the proposition has been discussed that a National University should be established in Washington to represent that projected by Washington himself, and for which he provided, as he supposed, in his will. The foundation, for various reasons, did not materialize, and though one of the reservations in the original plat of the capital city was designated by Washington as a site for the proposed university, no funds being forthcoming, the scheme until lately has remained dormant.

Recently, owing to the interest and enthusiasm of a number of friends of education, the scheme has been revived and much popular interest expressed; several bills have been laid before Congress, and steps taken toward securing popular subscriptions, and the use of a site in the District of Columbia, on one of the public reservations for projected buildings, to be used in connection with the work of the university.[1]

[1] The originally designated plat was afterwards used for the Naval Observatory, and has recently been abandoned, partly on account of the prevalence of malaria.

As far as university instruction of the ordinary American type is concerned, the District of Columbia is already well supplied with the means of furnishing it. It is only necessary to refer to the names of the Georgetown University, the Catholic University, the Columbian University, Howard University, the National University, the proposed American University, and their associated special schools, to make this plain. While nearly all these institutions are more or less distinctly under the control of some religious denomination, I believe none of them confine their educational efforts to students of any one particular faith, and in most of them instruction is sufficiently free from sectarian bias to render the denominational control a matter of little importance to their students, except in so far as it tends to preserve a good standard of morals.

It is, I believe, admitted by the friends of the projected institution that there is no sufficient reason for establishing a new competitor for the opportunity of giving undergraduate instruction. Few friends of liberal education would advise that to the workers in a field already so well occupied, and most of whom are so poorly endowed, should be added another institution of similar character and aims. Generous givers might far better contribute to the strengthening of those already established. But it is claimed, and with some show of reason, that there is still room for an institution of a different character, in which those who have already acquired the essentials of a liberal education could pursue special branches of study, utilizing the opportunities which might be afforded by the government laboratories in various departments of science, to make of themselves highly skilled specialists, for whom the growth of the country is beginning to open a career.

Assuming, for the purposes of argument, that this contention is just, the present paper is intended to discuss, from the point of view of the official man of science, the practical questions of what relations between such an institution and the executive departments of the government are practicable and advisable; and also the organization best suited to promote harmonious and successful coöperation between the departmental laboratories and the members of such a university.

It must be said that the projectors of the enterprise have so far dealt chiefly in generalities, and have hardly touched upon the practical side of the question, which, nevertheless, is a factor upon which the success or failure of the scheme must very largely depend. In fact, most of the documents relating to the proposed university which I have been able to consult absolutely ignore this side of the matter, and even display an apparent ignorance of the conditions which have to be met. It is in the hope of throwing some light upon them, without partiality for or against the project, and in the hope of eliciting further information by discussion from those especially qualified to give it through their connection with the government laboratories, that this paper has been prepared.

Some thirty-four years' experience in the scientific work of the government has given the writer a tolerably good insight into the methods now or formerly in use and the conditions of this side of the problem. During this time the expansion of the scope of this work has been very great, and with the expansion has necessarily come more or less severity of restriction for the purpose of fixing responsibility, controlling expenditures, and defining the limits of work to be authorized. These restrictions have much increased the labor and difficulty of carrying on the work, and to some extent the expense of it. Every worker has realized this, and most have felt disposed to criticise it. The restrictions are frequently double-edged; made by legislators unfamiliar with the methods of science, and having one object in view, they sometimes, whether accomplishing that object or not, bear very severely on the worker in some other direction not at all originally in contemplation. Nevertheless the government has, on the whole, been generous, and the restrictions for the most part beneficial in that, if rigidly lived up to, they protect the scientific bureaus from ignorant and unjust attacks from those with a morbid appetite for scandal. In the last instance, somebody always has to be trusted, and the narrower the field for the exercise of untrammeled judgment, the less subject to unreasonable criticism is the person upon whom the responsibility is laid. This responsibility is divided between the executive head of a bureau and his subordinates

in various measure, but the chief part of it is shared by the Director and the "heads of divisions" who have the direct superintendence of the details of the work. The former, subject to the approval of the Secretary (which in most cases is given as a matter of course), decides the policy of the bureau in its special functions, the allotment of money and work to the different divisions, and the general character and quality of work which shall represent the bureau. He is also the general intermediary between the Department and Congressional committees concerned with the special work of the bureau, explaining the necessity for particular expenditures for which authority is asked, or the propriety of any action about which question has arisen.

The "head of a division" has generally the immediate control of work decided upon and of the special workers, supervises methods and estimates cost, is responsible for accuracy and economy in the use of the fund allotted to the work of his division, and the attendance and efficiency of those engaged in it. Upon him the Director relies for most details, and to him the individual workers look for their instructions.

Both the directors and the "heads of divisions" are usually overworked, and the latter are almost invariably underpaid. The necrology of the scientific staff from year to year shows a lamentable number of early deaths from causes directly or indirectly connected with overwork, "burning the candle at both ends." The temptation of the opportunity for research offered by government laboratories, and unequaled elsewhere, is responsible for the presence in them of many men who in private life would be enjoying the frugal living, high thinking, and long summer vacations of colleges, or from five to ten times their present salaries as consulting experts. Another feature of life in the laboratories is exemplified by the presence there of men who, by years of labor in their specialty, are known around the world as experts of the highest rank, whose contributions to science in a single year far outweigh the best college thesis for the doctorate of philosophy or science, and yet to whom the grant, by some appreciative Faculty, of this modest badge of honor would rouse from the mass of educators a storm

of protest. Such instances could be mentioned, and show conclusively how little general knowledge exists among educated men, not scientists, of the kind and quality of work turned out by the scientific bureaus. This brief statement of conditions is necessary for the clear understanding of the points which are to follow. Addressed to an audience of officials it would be unnecessary.

It is the writer's opinion that the university should be free from the trammels of government control, and that it should ask from Congress only its charter and the privileges of the laboratories; that it should not be a government institution, but should stand on its own merits. Perhaps the grant of a site for the university offices, on one of the larger reservations near the government buildings, might be accepted, as in the case of the Smithsonian; provided it was clearly understood that this did not constitute the university a governmental entity. The objections to its becoming such are many and serious, and will not be enlarged upon here; that it would dry up the springs of private bounty is certain, and is sufficient to condemn the proposition.

On the other hand, the grotesque project of forming its governing board of a dozen active presidents of existing colleges is so preposterous that it only needs to be stated to meet its fate with thinking people.

The university should have for executive purposes a governing board solely its own, and as small as possible, both for efficiency and economy. The faculty should decide on all matters connected with teaching and discipline, and the alumni be granted advisory status on large questions. One or two members of the executive board should be taken from the list of directors of scientific bureaus, but in their private, not their official capacity. A board wholly inexperienced in government routine and conditions would be constantly in hot water.

Various branches of university training stand somewhat outside the laboratory work, though more or less dependent upon the libraries and archives of the city. For these the appointment of professors would be required. There should probably

be a few administrative members of the faculty covering the branches which did avail themselves of the laboratories, but more to act in an advisory capacity to the student than to teach him. The laboratory student while at work should know but one executive head, the chief of division in whose laboratory his work is done. Any division of authority here would be fatal.

We would have then a small executive board, a small faculty, and, as it naturally follows, small administrative expenses. Concentration of power in the hands of competent men is the soul of efficiency and the warranty of success.

No funds should be sunk in pretentious buildings. A single building, with one large acoustically perfect hall, and as many smaller lecture rooms as seemed requisite, with offices for the archives, bursar, and administrative men, would be all that would be really necessary or useful, at all events for some time to come. Under these circumstances the funds contributed could be almost wholly devoted to the true purpose of such a university, the production of highly trained experts, and the endowment of research.

It is obvious that the interests of the government's own work would permit of only a small number of students in any one laboratory, such a number, in each case, as the chief of division felt certain could be advantageously utilized and controlled. It would be impracticable to admit professors or classes into any laboratory except as rare visitors, such as occasionally come now.

The laboratory student must come, if at all, as the regularly employed workers come, to keep the same hours, observe the same rules, and render to the chief the same obedience. For the class of men we are considering as possible students this would not be a grievous requirement. The method of instruction would necessarily be that of Agassiz. Actual work on actual material, with results in sight from the first, and methods absorbed through contact and experience not merely experimental. I think there are few chiefs of division who would not welcome one or two well-trained enthusiastic students under such conditions.

The question then arises as to how the reception of students might be controlled and organized. A simple resolution or bill in Congress, authorizing the scientific bureaus to admit, subject to the approval of the director and chief of division, such students as they may find qualified, and who can be employed with advantage to the work of the bureau, would be all the legislation that is needed; unless Congress should require that their presence should involve the government in no expense or responsibility, and authorize the officers above mentioned to make rules to cover the conditions. As these are different in each laboratory, the rules should be left to the authorities of each laboratory. The function of the university, as such, in the case of these students would then be limited, as in the case of London University, to a determination of their qualifications and the issuing of an equivalent degree, not necessarily by oral examination, but on the record of work accomplished, if it proved desirable. For such men the acquisition of the qualifications should regulate the duration of study, not some arbitrary period of time. The Director of the bureau should be authorized to accept or reject students, because he is responsible for the work of the bureau, and the Chief of division because upon him falls the responsibility for the success and proper conduct of his own divisional work, and whatever labor and time is required to direct and utilize the student. The position of the Chief of division with relation to the student and the university will then be that of a tutor or docent, and in return for his services to the student the university should provide a modest honorarium which might be refunded to the university by the student, or deducted from the amount of a scholarship if the student held one, or paid by the university as endowment of research. It would be better that no private arrangement between teacher and pupil should be permitted, but that such transactions should be handled by the university authorities, for obvious reasons. If the university were a government institution, it could not pay fees to any government official under the present law, which is not likely to be changed. It would be obviously unjust to add to the regular official duties of a laboratory chief the responsibility involved in the recep-

tion and supervision of pupils, without some remuneration. For the infinitesimal cost which might indirectly fall upon the United States through the presence in the laboratory of one or two students, the government would be amply repaid, both by the gratuitous labor of the student and by the creation of a body of experts already trained to government methods who might be available for sudden emergencies.

There remains to be provided for, the method of selecting from among candidates those who should be admitted to the privileges of the laboratories.

Candidates might be required to present to the proper officer of the university certificates of graduation, proficiency, experience, and moral character, with a statement of the line of work they desired to take up. These having been classified, the directors of the bureaus concerned, on notification, might appoint the chiefs of those divisions for whose privileges application had been made, and who should meet as a board or committee to discuss applications and report their decisions to the various directors. The conclusions of the committee having been ratified by the directors, and referred back to the board, could by it be transmitted to the university authorities, who could then announce to the successful candidates that, on matriculation and payment of university fees, they would be duly accredited to the laboratories concerned.

This method would enable the university annually to allot a small but picked body of the most promising students of the country to those places where they could get unique opportunities for special work; and would, in the course of time, produce a body of experts, many of whom would naturally gravitate into the government service, and all of whom would be available for special services to the government, if needed, in a way no other method of training could supply. If the university graduated only twenty such men in a year, it would more than justify its existence. It would thus not compete with any other institution, and would supply a training and experience not to be gained elsewhere.

There are of course, as in all human affairs, opportunities for friction and criticism in the plan proposed. The general

proposition that such a body as the proposed university should be admitted to such privileges is one upon which differences of opinion might naturally exist, and which is not discussed in this paper. Here I have assumed the affirmative reply to the general question, and merely presented for criticism and discussion the outline of a comparatively simple scheme by which the proposed relation between such a university and the government laboratories might be carried into effect. That it is practicable I am convinced from the experience of former days, when the towers of the Smithsonian sheltered a body of mostly impecunious but enthusiastic volunteer students, under the supervision of Henry and Baird, almost every one of whom in later days became distinguished for services rendered to science.

Should the plan suggested fail to recommend itself to the promoters of the new university, it would still be possible for any existing institution of learning, or any number of them in association, to avail themselves of the undoubted opportunities herein pointed out. The formulation of plans to this end would be simple and easy. In this connection I may quote a few paragraphs from an abstract of the current annual report of the Secretary of Agriculture, which has appeared in the daily press since the preceding paper was written.

The Department as an Aid to Post-Graduate Work.[1]

Regarding the facilities of the department for post-graduate instruction, the secretary says there is no university in the land where the young farmer may pursue post-graduate studies in all the sciences relating to production, but that the scientific divisions of the Department of Agriculture can to some extent provide post-graduate facilities.

The chiefs of divisions are very proficient in their lines, the apparatus the best obtainable, the libraries the most complete of any in the country, and the studies of a few bright people could be directed in each division, so that when the department requires help, as it often does, the services of these young scientists would be available.

These students should be graduates of agricultural colleges, and should come to the department through an examination that would bring the best young men. The capacity of the department is limited ; but assistants are

[1] *Washington Evening Star*, Dec. 2, 1898.

often tempted to accept higher salaries in state institutions, and the opening of the laboratories to post-graduate work would provide an eligible list to fill vacancies as they occur, supply temporary agents, and be a source from which state institutions might get assistance in scientific lines.

ADDENDUM. — The preceding paper, for the purpose of eliciting discussion and suggestions, was read at a meeting of the Philosophical Society of Washington, Dec. 10, 1898, and some of the points raised may advantageously be noted here.

The discussion took a turn toward the distinct proposition of a governmental university, which was considered by Prof. Lester F. Ward and Surgeon-General Sternberg, but which the present writer regards as impracticable, even if desirable, under present conditions.

The points bearing on the proposition advanced in this paper, and which it seems desirable to notice, are as follows:

1. That the organization proposed would not constitute "a university."

The writer is entirely indifferent as to the title of the proposed institution. What he has tried to show is a practicable means of utilizing certain at present unused opportunities of great value to special students.

2. That the plan would not accommodate all who might apply, and that some bureaus might not be willing to accommodate any students.

This is, of course, the essence of the problem. It would in any event be impracticable and unwise to hamper the bureaus by undesired additions to their corps. But the competition for the opportunities would make them even more desirable to the ambitious student, and secure for them the most promising men. The plan is essentially intended as selective of, and only of, the very best.

3. That while in certain lines there might be opportunities for a fair number of students, the fact that there were other lines in which no students could be accommodated would render the distribution of the men among the different branches of science unequal, or, to use the phrase of one of the critics, the "university would be lopsided."

I have never heard of any university in which the number of

students pursuing special post-graduate courses was equal, or nearly equal, in the different specialties. Tastes are not equally represented in the graduate population any more than opportunities in the world at large. At any rate, no more could be utilized than exist, and if the numbers in different lines are unequal, this is no reason why any of them should be wasted.

Doubts as to the workability of the scheme here proposed were only expressed by one or two persons, none of whom had had practical experience in the laboratory work, and I would repeat that I have entire confidence in its practicability, knowing from my own experience that many students have passed from temporary post-graduate employment in the laboratories to lucrative and successful employment elsewhere.

THE RELATION BETWEEN FORESTRY AND GEOLOGY IN NEW JERSEY.

ARTHUR HOLLICK.

II. Historical Development of the Flora.

Within the boundaries of the state are geological formations representing all the great time divisions — Eozoic, Palæozoic, Mesozoic, and Neozoic — and rocks of all the included geologic periods, with the exception of the Carboniferous and Jurassic. In tracing the development of plant life through geologic time the fact is well recognized that the flora of Eozoic and Palæozoic times is not related to our living flora by any closer ties than those of sub-kingdoms or classes. In Mesozoic time generic relationships may be traced, while in Neozoic time many species either identical with or closely related to living ones may be recognized.

It has also been accepted as a broad generalization that biologic development has been coincident with geologic sequence, or, in other words, that the farther back in geologic time we begin our investigations the lower in the scale of life we find the plants to be; and, conversely, that the nearer we approach modern time the higher they are in development. Plants have developed in the past in accordance with changes in their environments, as they do to-day, so that in order to understand the evolution of any living flora it is necessary to know something about the changes which have preceded the existing conditions.

For the purposes of this discussion we need not begin any farther back in geologic time than the Triassic period, when the shore line of the North American continent, so far as New Jersey is concerned, extended irregularly from about the vicinity of Mahwah to a few miles south of Phillipsburg. This was evidently a period of slow subsidence, and the Triassic deposits were largely laid down in shallow estuaries or lagoons, which

were alternately covered with the tides and exposed to the atmosphere. The rocks are mostly conglomerates, sandstones, and shales, evidently shore or shallow water deposits, often ripple-marked or sun-cracked, and occasionally bearing the footprints of land animals or amphibians which wandered over them.

The vegetation of the period is but sparsely represented in the collections which have been made in New Jersey, but these probably fairly represent its general characters. Dr. J. S. Newberry has described about ten species from the state,[1] of which three are pteridophytes, and the remainder probably all referable to the gymnosperms. One living genus (*Equisetum*) is recognized.

Thus far, in any collection of Triassic plants which has been made, nothing higher in development than the monocotyledons is even indicated, and we may regard the Triassic flora as one composed almost wholly of ferns, cycads, and conifers, with cycads as the dominant type.

Towards the close of the Triassic period great physical changes occurred, of which the extrusion of trap dikes was one of the most prominent features. The indications also are that that portion of the continent now represented by New Jersey and vicinity was raised above its former level and remained so for a long time, while farther south it was depressed, as in this state we know of no deposits which can be even provisionally referred to the next succeeding period, the Jurassic, which, however, occur in Maryland and southward. In New Jersey, therefore, we have a break at this period in the geologic sequence, and in consequence a hiatus in the line of plant development which has been at least partially bridged by Prof. Wm. M. Fontaine and Dr. Lester F. Ward in their studies of the Potomac flora of Maryland and Virginia.[2] The exact geologic age of the lower strata of this formation has not been definitely settled,

[1] Fossil Fishes and Fossil Plants of the Triassic Rocks of New Jersey and the Connecticut Valley, *Monographs of the United States Geological Survey*, vol. xiv.

[2] Fontaine, Wm. M. The Potomac or Younger Mesozoic Flora, *Monographs of the United States Geological Survey*, vol. xv, pts. i and ii.

Ward, L. F. The Potomac Formation, *Fifteenth Annual Report of the United States Geological Survey*, pp. 307–397.

but all the evidence thus far adduced from the fossil plants indicates a transition from the Triassic flora below to the typical Cretaceous flora above.

In this transition flora, accompanying the pteridophytes and gymnosperms, are numerous archaic types of angiosperms and others in which generic relationships with living plants are more or less definitely indicated. Others more closely related are described under such names as *Ficophyllum*, *Sapindopsis*, *Saliciphyllum*, *Quercophyllum*, *Eucalyptophyllum*, etc., while not a few living genera are recognized (*Torreya*, *Sequoia*, *Araucaria*, *Taxodium*, *Sassafras*, *Myrica*, etc.). The number of pteridophytes and gymnosperms as compared with the angiosperms is about 4 to 1, so that the lower types of vegetation were evidently yet in the ascendant.

The limited number of modern elements contained in this and the preceding flora render a comparison with our living flora somewhat hazardous so far as any conclusions as to climate are concerned, but we may safely say that in their general character they indicate tropical or subtropical conditions.

The strata next succeeding the Triassic in New Jersey consist of clays, sands, and gravels, which are apparently Middle Cretaceous in age. This indicates a later submergence of the New Jersey area, when the shore line was approximately where we now find the southern edge of the Triassic outcrop to be, extending from Woodbridge to Trenton.

This was evidently a period of quietude and slow subsidence, as the deposits are largely clays and fine sands in which immense quantities of land vegetation are entombed, many of the specimens being so delicate that it is difficult to understand how they could have been preserved at all, except in very quiet or exceedingly sluggish waters. The occurrence of a few marine molluscs indicates that the waters were at times subject to tidal influence, but essentially they must have been fresh or perhaps brackish.

This flora has been described by Dr. Newberry,[1] who recognized in it 156 species, of which all but about thirty are angio-

[1] The Flora of the Amboy Clays, *Monographs of the United States Geological Survey*, vol. xxvi.

sperms, nearly all of them included under living genera. Many of these now inhabit the region, such as *Diospyros*, *Juglans*, *Liriodendron*, *Magnolia*, *Populus*, *Salix*, etc.; but others are of more southern distribution, such as *Bauhinia*, *Cinnamomum*, *Eucalyptus*, *Ficus*, *Laurus*, *Passiflora*, *Sequoia*, etc.

No living species is recognized, although close specific relationship is commented upon in several instances, and is indicated in at least one of the names adopted (*Magnolia glaucoides*).

The most significant feature of the flora as a whole is the complete reversal of the proportions between the angiosperms and gymnosperms as compared with their proportions in the preceding flora, the angiosperms being now overwhelmingly in the ascendant, while in the gymnosperms the conifers are more abundant than the cycads.

The genera also indicate a less tropical climate than that which previously prevailed, but one which was considerably warmer than now obtains in the region.

After the clays had been laid down as estuary or brackish water deposits, the submergence continued, and we next find the clay marls, representing the transition to marine conditions. In these the land vegetation is less abundant, but is not noticeably different in its general characters from that which preceded it.[1]

The subsidence continued and true marine conditions supervened. The marls were deposited, and in them nothing but marine organisms are preserved. Thus far we have not found any record of the land vegetation which occupied the region during this period, but in the west the conditions were different, and the remains of Upper Cretaceous plants are abundantly preserved in the Laramie and allied deposits. In these most of the Middle Cretaceous genera are found to continue, and a number of new ones to appear, but the species in all but a very few instances are different, and the monocotyledons begin to assume prominence for the first time, in the form of fan palms.

Generically this flora is more closely related to our living flora than was that which had preceded it. The number of

[1] Hollick, Arthur. The Cretaceous Clay Marl Exposure at Cliffwood, N. J., *Trans. N. Y. Acad. Sci.*, vol. xvi (1897), pp. 124–136.

living genera included in it was actually and relatively greater, and the species are of a more modern aspect; but none is apparently identical with any now living.

The ratios between the pteridophytes, gymnosperms, and angiosperms were approximately about as we find them to be at the present time, and the climatic conditions were apparently yet subtropical.

During the early and middle parts of the next succeeding period, the Tertiary, the indications are that while there were minor oscillations of level, the previous gradual subsidence continued until the shore line had advanced far inland, covering the entire region which we know as the coastal plain, and causing the sediments to be deposited which we recognize in the aggregate as the Yellow Gravel formation. In places this is undoubtedly of marine origin, while in others it is apparently due to floods of fresh water. At one locality only, in the vicinity of Bridgeton, has the flora of this period been found in the state. Fortunately the remains there preserved were collected in abundance and in excellent condition. Probably about fifty well-defined species are represented in the collections which have been made; all of them angiosperms; many of them referable to living species, or so closely identical that it is not possible to separate them; some of the latter the same as species now growing in the vicinity of Bridgeton (*Ilex opaca, Nyssa aquatica*, etc.).

A comparison between this fossil flora and the living flora of eastern North America indicates a close identity between the former and that now in existence somewhat farther south, say at about the latitude of Virginia.[1]

Theoretically this Bridgeton flora should be Pleiocene or late

[1] The study of this flora has not yet been completed, but the preliminary conclusions may be found in the following papers:

Palæobotany of the Yellow Gravel at Bridgeton, N. J. Arthur Hollick. *Bull. Torrey Bot. Club*, vol. xix (1892), pp. 330–333.

New Species of Leguminous Pods from the Yellow Gravel at Bridgeton, N. J. *Ibid.*, vol. xxiii (1896), pp. 46–49.

A New Fossil Monocotyledon from the Yellow Gravel at Bridgeton, N. J. *Ibid.*, vol. xxiv (1897), pp. 329–331.

In the above papers may also be found references to the work of others in the same locality.

Miocene in age, but in many of its elements it is unique, and is distinct from that of any other American Tertiary locality. The collections of Eocene and Miocene plants which have been made in the west contain different species, and those from Bridgeton are rare or else entirely wanting in them. As a whole, however, the flora seems to be more nearly comparable with that of certain European Miocene localities, and this idea is also in accordance with the well-recognized fact that plant development was more advanced in Europe than in America. Thus European Eocene plants are in part represented by Miocene plants in America. European Miocene by American Pliocene, and European Pliocene by our present living flora. From its general character I am inclined to consider it as more recent in age than that of any other recognized Tertiary horizon in America.

Towards the close of the Tertiary period an era of elevation began which raised the northern part of the North American continent many hundreds of feet above its former level and extended the shore line out far beyond its former or present position, so that the edge of the continent was about where we now find the one hundred fathom contour to be.

Up to this time in the world's history we have every reason to believe that there were no extremes of climate between the poles and the equator such as prevail to-day. The temperature of the entire earth's surface was more or less uniform during each of the several periods, up to and including the Tertiary, although a constant change had been in progress from tropical to temperate conditions.

The elevation which began in the Tertiary period, however, caused, or at least was coincident with, the greatest changes, climatic and biologic, which are anywhere recorded in geologic history. The climate gradually became more and more severe, and finally culminated in what we call the Glacial epoch of the Quaternary period.

That the changes wrought were gradual, extending over a long period of time, we are justified in concluding, for the reason that the vegetation which was in existence at the time when it was finally overwhelmed by the accumulations of ice

and snow was identical in all respects with that of to-day over the same region. In other words, the flora of the Tertiary period had become modified to the new conditions before its final extermination by the ice sheet, which extended southward in New Jersey as far as Perth Amboy in the east and Belvidere in the west. Every species thus far discovered in the Quaternary clays and gravels, or in old peat bogs beneath the bowlder till, is identical with some living species, and this evidence of modification to meet changing conditions implies a long period of time. Such species as were located within the area of glaciation were of course absolutely exterminated, while others were driven southward, and only such as could exist under these vicissitudes remained to reëstablish themselves after the final recession of the ice.

I do not know of any remains of the vegetation of this period having been found in New Jersey, and such as have been found elsewhere are scanty in amount.

The final recession of the ice was accompanied by a subsidence of the land, and this subsidence was probably the cause of the recession in the same way that the previous elevation had been the cause of its accumulation. Several oscillations of level occurred, and finally the land assumed the contour and topography of to-day.

At the present time, so far as New Jersey is concerned, a slow subsidence of the land is recognized as taking place, which amounts to about two feet per century. This rate of movement, while very slow, is probably no greater than that which produced such tremendous changes of level and such far-reaching effects in the past, and we have but to consider the cumulative effects in order to appreciate that a few centuries hence great changes in topography may be effected. Even within historic times the subsidence of the land has caused the coast line to advance inland in many localities, so that what was once upland has become salt meadow, while salt meadow turf and tree stumps are found far out in the ocean bottom, beyond the present shore line.

Recognizing these facts, the question naturally arises as to the ultimate result, provided the present conditions continue.

Manifestly the flora which occupies the coast region will have its habitat more and more restricted in area, and will be driven more and more towards the tension zone, where the struggle for existence will become fiercer and the weaker elements will succumb. Thus not only are the physical changes in the environment inimical, but also the trend of biologic evolution. The sequence of events in the evolution of the vegetable kingdom show conclusively that the gymnosperm type is a waning one, and that the more highly developed angiosperms have been slowly but inevitably crowding it out since early Cretaceous times, and at the present time, in any competition for the occupancy of a region at all favorable for the angiosperms, these latter are sure to prevail, and the conclusion appears to be inevitable that the flora of the coniferous zone is destined to be ultimately obliterated or only to exist over limited areas, often for the negative reason that in such areas the conditions may not be favorable for the growth of other types. The influence of man may produce temporary changes and give temporary advantage one way or the other, as may often be seen in the occupation by cedars or pines of land which has been recently cleared of deciduous trees ; but such changes are artificial and sporadic and cannot prevail over the constant and inevitable progress of physical and organic evolution.

Not only is the gradual extinction of the gymnosperm type thus indicated, but by the same method of reasoning the angiosperms characteristic of the coniferous zone must of necessity be the first to die out in that class, not only because of the gradual restriction of the area which they occupy, but also because, as is well known, the genera represented are older and the flora as a whole is less modern in its characteristics than obtain in the angiosperm flora of the deciduous zone. The genera of the coniferous zone are largely confined to America, whereas those of the deciduous zone are largely common to both America and Europe. These latter are thus of wide and varied distribution ; they occupy a region practically unrestricted in area, and represent more recently evolved types of vegetation.

THE WINGS OF INSECTS.

J. H. COMSTOCK AND J. G. NEEDHAM.

CHAPTER IV (*continued*).

The Specialization of Wings by Addition.

IV. THE VENATION OF THE WINGS OF EPHEMERIDA.

THE determination of the homologies of the wing-veins of May-flies appears, at first sight, to be an extremely difficult problem; for the wings of these insects are very different from those of any other order. But, as soon as one understands the ways in which the wings have been modified, it is easy to identify the principal veins.

In this order a marked cephalization of the flight function has taken place, which has resulted in a great reduction of the hind wings of all living forms. In some cases (*Cænis et al.*) this has gone so far that the hind wings are wanting.

In a few genera (*Oligoneura et al.*) both pairs of wings are furnished with but few veins. It requires only a little study, however, to convince one that these genera with few-veined wings are degraded and not generalized. It is in the fore wings of those forms in which many wing-veins have been retained that the homologies of the wing-veins are most easily determined.

Fig. 69 represents the venation of a species which will serve well as a type of the recent May-flies; and the lettering of the figure indicates our conclusions regarding the homologies of the veins. But the most characteristic feature of the wings is not shown in the figure. If the reader will examine one of the larger May-flies, he will see that the corrugation of the wings is much more perfect than in any other order of insects, extending to all parts of the wings.

This fan-like structure of the ephemerid wings has been referred to by many writers. But it is worth while to point

out in this place the degree of perfection that has been reached in the alternation of convex and concave veins. In the accompanying table the names of the convex veins, those veins that follow the crests of ridges, are printed in Italics; while the names of concave veins, those veins that follow the furrows, are printed in Roman type.

Table of Wing-Veins of Ephemerida.

C.	*Costa*			*C.*
Sc.	Subcosta			Sc.
R.	*Radius*			R_1
Rs.	Radial sector	Vein R_{2+3}	Vein R_2	R_2
			Vein R_3	R_3
		Chief accessory radial vein		1
		Vein R_{4+5}	*Vein* R_4	R_4
			Vein R_5	R_5
M.	*Media*	*Vein* M_{1+2}	*Vein* M_1	M_1
			Vein M_2	M_2
		Vein M_3		M_3
Cu.	Cubitus	Vein Cu_1		Cu_1
		Chief accessory cubital vein		*1*
		Vein Cu_2		Cu_2
1st A.	*1st Anal vein*			*1st A.*
2d A.	2d Anal vein			2d A.
3d A.	*3d Anal vein*			*3d A.*

One of the most characteristic features in the venation of the wings of May-flies is that the radial sector plays the part of a principal vein; it originates near the base of the wing; and, as a rule, it is detached, in the adult, from the main stem of the radius.[1] For this reason it is given the position of a principal vein in the table.

If this modification be made, it will be seen that, when the principal veins are considered, there is a strict alternation of convex and concave veins; and that in the case of the forked veins (the radial sector, the media, and the cubitus) the principal branches of a vein are of the same nature as the main stem.

It will also be seen that this alternation of convex and concave veins exists in the distal portion of the wing. In those

[1] In certain Plecoptera and Trichoptera the radial sector of the hind wings is detached in a similar manner.

cases where a vein has an even number of branches (the radial sector and the cubitus) the alternation has been attained by the development of an accessory vein. These are indicated in the table as chief accessory veins, and are lettered 1 in the figure. Many other accessory veins are developed at the margin of the wing in a more or less irregular manner; but whenever a second accessory vein extends far into the disk of the wing it is accompanied by a third, one being convex, the other concave. The anal area of the wing, where the accessory veins are more of the nature of braces, like cross-veins, is not included in this statement, nor in that which follows.

Correlated with the development of a triangular form of wing, which involves an expanding of its outer margin, is the fact that the accessory longitudinal veins are all added distally in the May-flies. But the method of development of these veins appears to be radically different from what it is in the Neuroptera.[1] There the accessory longitudinal veins are preceded by tracheæ, which arise as fine twigs at the tips of older tracheæ, and which in the course of phylogenetic development branch off from the parent tracheæ farther and farther from the margin of the wing, thus making room for the development of other twigs. Here, in the May-flies, the accessory longitudinal veins are evidently thickened folds, which arise more or less nearly midway between other veins. A similar thickening of a fold occurs in the Diptera, where, in certain Asilidæ, the anal furrow is vein-like in structure.

A fact of prime importance in the study of the homologies of the wing-veins of May-flies is that the corrugations of the wing are the most persistent features of it. Hence the most important criterion for determining the homology of a vein is whether it is a concave or a convex one. The basal connections of the veins are very inconstant, and are often misleading. We have already referred to the separation of the radial sector from the main stem of the radius in the adult (its true origin is easily seen when the tracheation of the wings of certain nymphs is studied); and other separations and secondary attachments are common. A good illustration is furnished by the wings

[1] See *American Naturalist*, vol. xxxii, pp. 771, 772.

represented by Fig. 69. In the hind wing, vein Cu_2 is apparently a branch of the first anal vein (marked *A* in the figure); but in the fore wing, which is less modified, its primitive connection is preserved; although even here a prominent bend has brought it near to the anal vein, and only a step more would be required, the fading out of the basal section, to reach

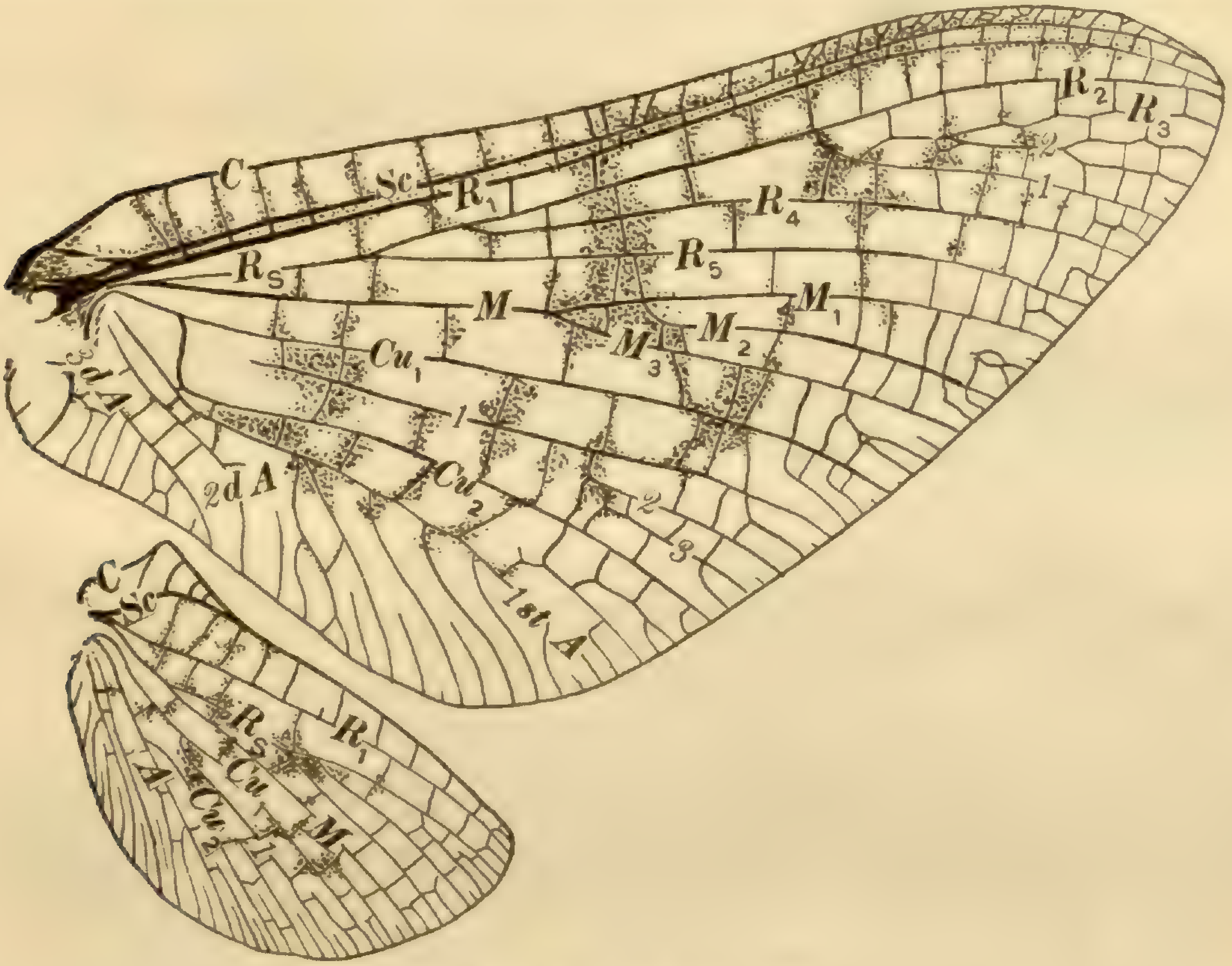

FIG. 69. — Wings of *Ephemera*.

the condition attained in the hind wing. But the concave nature of this vein in the hind wing indicates its homology in spite of its misleading basal connection.

It should be remembered that the convex or concave nature of a vein is the result of a corrugation of the wing and not the cause of this corrugation. The theory of Adolph that the two sets of veins have a different ontogenetic development has absolutely no foundation in fact, as will be seen when we come to study the development of wing-veins, and as was suspected by Brauer and Redtenbacher.[1]

The primitive insect wing was doubtless flat. It makes no

[1] *Zoologischer Anzeiger*, 1888, p. 443.

difference, so far as this point is concerned, whether we believe that the wing is a modified tracheal gill or a transformed parachute-like expansion of the body wall. In either case it is highly improbable that it was fanlike at first. It was not until the wing became an organ of flight that a corrugation of it was beneficial; and even then this corrugation did not spring into existence suddenly, only to be lost in most of the orders of insects; as must be inferred, if we accept the theory of Adolph, that the wing of a May-fly represents the primitive type of this organ.

The stiffening of the costal margin of the wing by the formation of a subcostal furrow has been attained in most of the orders of insects; and in several of them the formation of folds has extended, to a greater or less degree, to other parts of the wing. But, as a rule, this method of specialization has not been the most important one in perfecting the wing. In the Odonata it has been carried farther than elsewhere, among living insects, except in the Ephemerida. But in the Odonata it has been supplemented by other methods of specialization, already discussed, with the result that an exceedingly efficient organ of flight has been developed in that order; while in the Ephemerids the cephalization of the flight function and the corrugating of the wings have been the chief lines along which specialization has extended. The former has doubtless added much to the efficiency of the wings; but a too close adherence to the latter method of specialization has resulted in the formation of a rather indifferent organ; although it is the most perfect development of its peculiar type.

We have studied the tracheation of many nymphs of May-flies, but with results much less satisfactory than those we have reached in the study of other orders of insects with many-veined wings. In all nymphs of May-flies that we have examined, a greater or less reduction of the tracheæ appears to have taken place; and in many of them a large proportion of the longitudinal veins contain no tracheæ. And, too, the presence or absence of a trachea in a vein appears to have little significance. As an example of this the wings of two nymphs are before the writer, in which the venation is so similar that there

is not the slightest difficulty in tracing the homologies of the veins. In one the radial sector and the media contain well-preserved tracheæ; in the other there is not the slightest trace of a trachea in these veins. On the other hand, in the latter the cubital trachea is forked, one of the branches traversing vein Cu_2; while in the former the cubital trachea is simple, there being not the slightest indication of a trachea in vein Cu_2.

The basal connections of the trachea of the wing are very different from what we have seen elsewhere. In the Plecoptera there are two distinct groups of tracheæ which enter the wing;[1] the same is true of certain cockroaches;[2] in all other forms

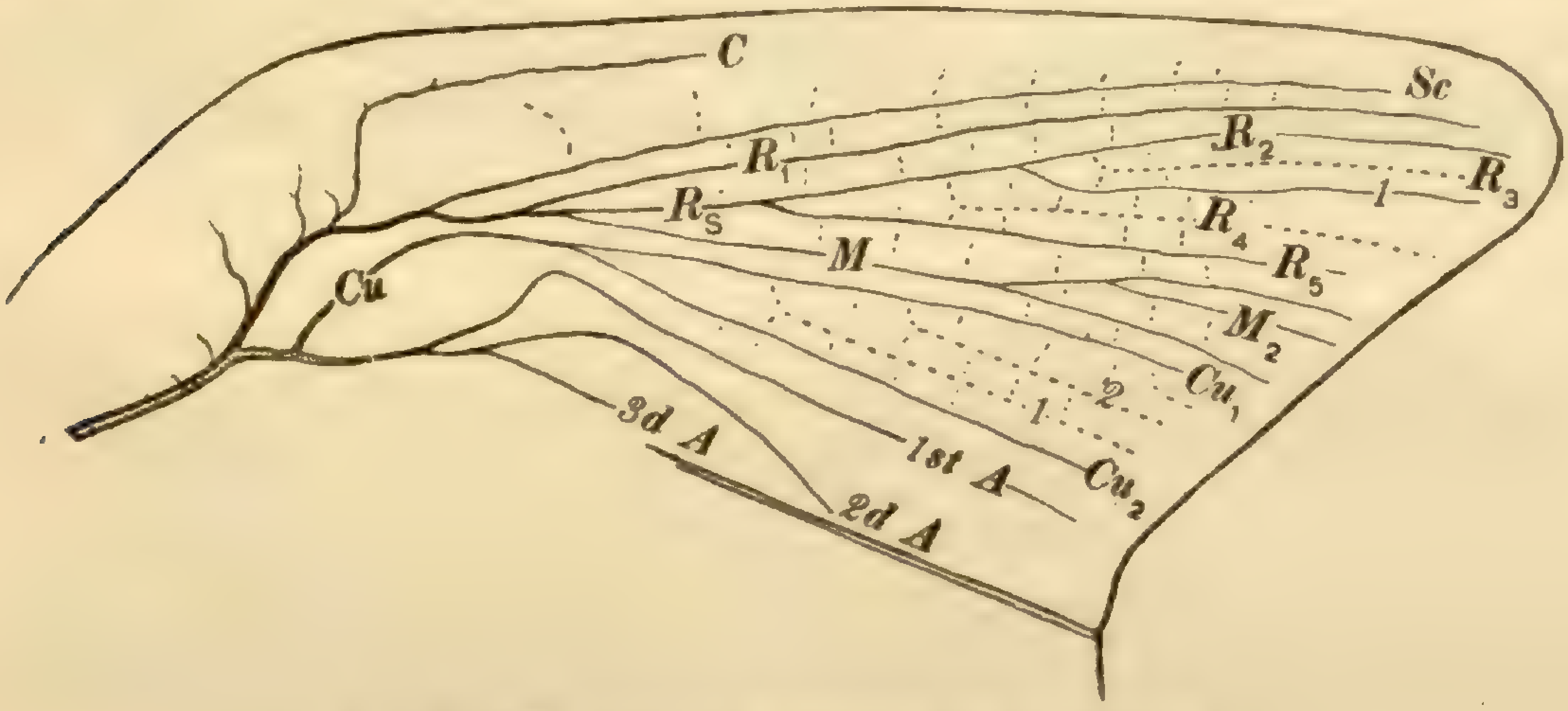

FIG. 70.—The tracheation of a wing of a May-fly nymph.

that we have studied, except the May-flies, a transverse basal trachea connects these two groups, and from this transverse trachea (transverse in relation to the wing, but longitudinal in relation to the body) the principal tracheæ of the wing extend more or less nearly at right angles to it.[3] In the May-flies a single trachea arises from the principal longitudinal trachea of one side of the thorax, and, after giving off a branch to the corresponding leg, passes directly to the base of the wing. Here it divides into several branches which continue in approximately the same direction and become the principal tracheæ of the wing.

In some cases this trachea extends into the wing before it divides. But in other forms, which we regard as more general-

[1] *American Naturalist*, vol. xxxii, p. 238, Fig. 8; p. 239, Fig. 9.
[2] *Loc. cit.*, p. 773, Fig. 56. [3] *Loc. cit.*, p. 772, Fig. 54.

ized, it separates into two trunks in the thorax near the base of the wing (Fig. 70); from one of these arises the costo-radial group of tracheæ, and from the other the cubito-anal group.

Fig. 70 will serve to illustrate what may be considered the type of tracheation of the wings in this order. It was made from a study of the nymphs referred to above. The positions of those longitudinal veins that contained no tracheæ in these nymphs are indicated by dotted lines.

The discussion of the venation of the wings of Ephemerida brings up the question of the venation of the primitive insect wing. For, in several of the more important papers on the homologies of wing-veins, it has been assumed that the wings of May-flies resemble closely the wings of the primitive winged insect.

The great preponderance of the many-veined type among the insect wings that have been found in the Carboniferous rocks has doubtless strengthened the quite generally accepted view that the primitive winged insect had many wing-veins. Thus Redtenbacher states:[1]

> The geologically older Orthoptera and Neuroptera show a much richer venation than the Coleoptera, Lepidoptera, Hymenoptera, and Diptera; likewise among the Rhyncota, the oldest forms, the Cicadas and the Fulgoridæ, possess much more numerous veins than the Hemiptera. There is apparently, then, no doubt that the oldest insect forms were provided, to a certain extent, with a superfluity of veins, and that, in the course of development, all the superfluous veins disappeared by reduction, and in this way a simple system of venation was brought about.

But we have shown that all the existing types of insect wings can be derived from one in which there are but few wing-veins — our hypothetical type, already figured several times. The deviations from this type in the more generalized members of the greater number of the orders of insects is slight. And we have pointed out the ways in which it is being modified, on the one hand by the coalescence of veins, and on the other by the development of accessory veins. While this is easy to understand, it is very difficult to conceive how the wings of the Lepidoptera, Diptera, and Hymenoptera could have been

[1] *Annalen des k. k. nat. Hofmuseums*, Bd. i, p. 153.

evolved from a wing of either the ephemerid or neuropterous type. After a wing had been strengthened by many cross-veins, it is not probable that these should disappear with the exception of the few to which we have applied names[1] in so many different orders, in so nearly an identical manner. Forms with reduced venation occur in most of the orders, but the results of these independent reductions differ greatly from each other. It is necessary, therefore, to examine again the paleontological evidence.

The great preponderance of many-veined wings in the Carboniferous rocks is probably due to the fact that doubtless then, as now, insects with many wing-veins were the ones that lived near water, and were, therefore, the ones most likely to be preserved as fossils.

Another point which should be taken into account is that, notwithstanding the great antiquity of the Carboniferous times, it was a comparatively late period in the history of insects, for winged insects appeared in the Silurian. We are carrying our investigations back only a step, although it is a long one, towards the period when wings were first developed by studying Carboniferous fossils.

Unfortunately, our knowledge of Silurian insects is meager. Moberg has figured an insect from the upper part of the lower Silurian; and Brongniart has figured and described a wing from the middle Silurian sandstone of Calvados, France. This we believe is all that is known regarding the insect fauna of the Silurian; and when we take into account the immensity of the period of time occupied by the deposition of the Silurian rocks, we are forced to admit that we know almost nothing regarding the older insects.

Of the Devonian insects, the remains of several are known. Those which are best preserved are *Homothetus fossilis* (Fig. 71), *Xenoneura antiquorum* (Fig. 72), and *Platephemera antiqua* (Fig. 73). (The figures given here are reproduced from Plate VII of Mr. Scudder's *Pretertiary Insects*.) A glance at these figures will convince the reader that the insects of the Devonian times varied greatly in the structure of their wings. For

[1] *American Naturalist*, vol. xxxii, pp. 233, 234.

these three insects differ as much from each other as do the more generalized members of widely separated orders of living insects. Evidently, comparatively high specializations in widely

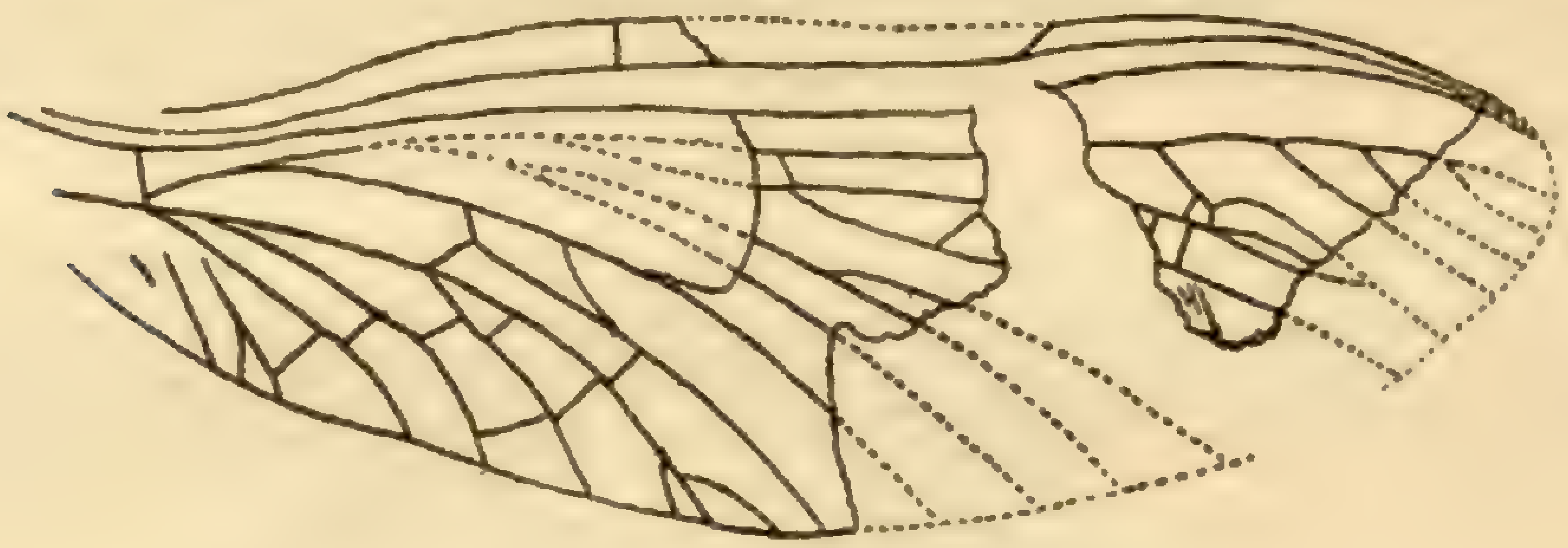

Fig. 71. — *Homothetus fossilis.*

Fig. 72. — *Xenoneura antiquorum.*

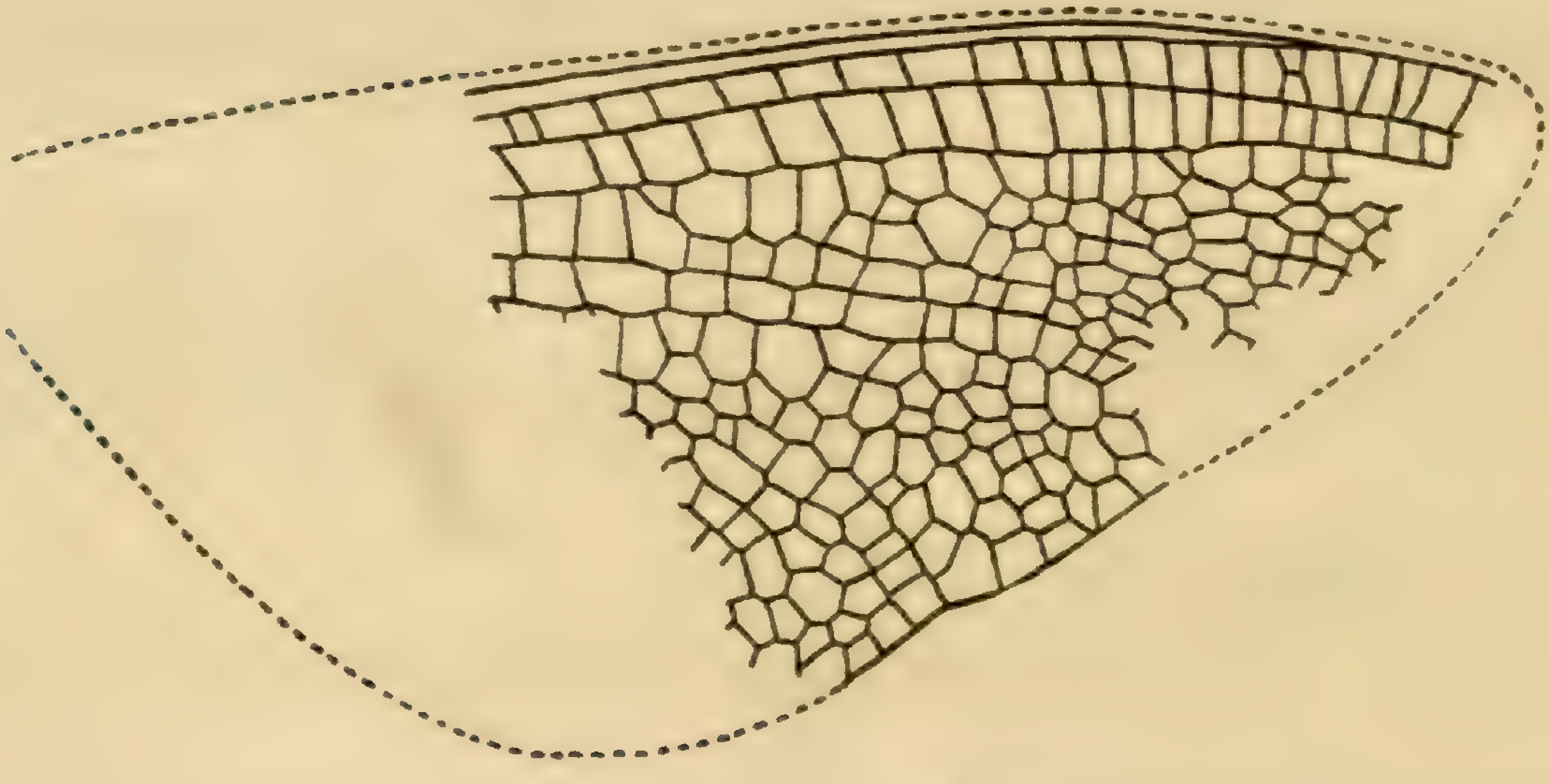

Fig. 73. — *Platephemera antiqua.*

different directions had been attained already at that early time. But the point to which we wish to call especial attention is that, of the three better-preserved Devonian insects, one (*Xenoneura*) had but few wing-veins. And when we consider the

slight amount of data that we have, the numerical preponderance of the many-veined type has no significance.

It is easy to conceive of the development of the wings of all living insects from forms allied to *Xenoneura*, by the different methods of specialization which we have pointed out; for it will be seen that the wing of this insect closely resembles our hypothetical type. And we can say, therefore, that the paleontological evidence does not contradict the conclusions drawn from a study of the ontogeny of living forms.

THE PENEPLAIN—A REVIEW.

R. A. DALY.

ALL workers in Physical Geography are agreed that, given time enough and a constant position of the baselevel, the general processes of denudation on the land will produce, as the result of wearing down any massif, a nearly plane surface approximately coincident with the baselevel of the region. Professor Davis and his followers believe that this ideal condition is represented by actual examples in nature, examples which deviate from the ideal in features that are the expected concomitants of even long-continued denudation. Chief among these is the occurrence of isolated areas of higher ground than the general plain, existent as such because of greater initial elevation of those parts of the massif or because of their being composed of exceptionally hard rocks; they are the "monadnocks" dominating the otherwise nearly featureless plain. That, in such a case, we have to do with an almost-plain, a peneplain, is regarded as none the less certain on account of the presence of these residual hills; on the contrary, they furnish one of the strongest arguments for the fact of denudation. The nearly plane surface of the rest of the massif can be quite independently recognized in the field and on the map. In a recent number of the *American Geologist*[1] Professor Tarr states his opinion that, while conceding the possibility of peneplains on an ideal planet, they do not exist, have not existed, and, if I understand him aright, *can* not exist on this earth of shifting baselevels, moving up and down within time limits represented by one or more geological periods.

Professor Tarr's arguments against the theory of peneplains are both general and special. In the former category are the following: (1) The theory is faulty because it demands too much time. (2) Closely correlated therewith is the objection

[1] June, 1898.

that continental oscillations of level are too pronounced, both from the point of view of amplitude and of frequency, to allow of the amount of beveling requisite to reduce a mountain-built region to the faint relief of a peneplain. (3) There is no known case of a modern extensive peneplain standing at its baselevel. (4) The paper is, however, largely occupied with a concrete argument against the peneplain from an analysis of the facts of land-form in two of the classic regions where the peneplain was first described, namely, in New England and New Jersey.

Before proceeding to a detailed discussion of these various points it is necessary to observe that, in order adequately to demolish the theory, it must be inspected, not only in the writings of the American physiographers, but also in those of European authorship. The peneplain is an American idea, but it has taken firm root in Europe. Men like Penck, Philippson, De Margerie, and De Lapparent are recognizing its truth, and we read of the peneplains of Bohemia, Russia, and the Rhine district; yet we cannot say that these men are specially omnivorous of American geological and geographical conclusions. We may most heartily agree with Professor Tarr in his calling a halt on the wholesale discovery of peneplains on insufficient evidence, but that criticism does not apply to the examples cited.

1. Professor Tarr refers to the difficulty of finding time enough for the process of the peneplanation of a mountainous tract, from the fact that, since the glacial period, there has been sufficient time neither to "strip off the till left by the ice upon the hillsides [of New England], nor to notably modify the very perfect form of drumlins, eskers, and deltas formed when the ice was here." "When we see the slowness of denudation in a hilly country, even a single peneplain seems most difficult to conceive." Is it easier to *conceive* (*i.e.*, actually measure out in the imagination) a stretch of time long enough even to permit of the excavation of the Colorado Canyon or the retreat of the Niagara escarpment fifty miles or more from the former edge of the Niagara limestone, or to produce the bewildering network of valleys in the West Virginia plateau? Whether we

can conceive many geological processes or not does not alter the facts of geology. The velocities of the planets are real, though never adequately conceived by the astronomer. The work has been done — "How?" is the question. To reason truly and effectively about the genesis of a land-form, we must put away from our minds any proneness to measure the scale of the operations by reference to the standards of a human life. It is safe to say that the best work in geology has been done by those observers who have thus put themselves in a sympathetic relationship with the earth and have looked upon her as a great organism whose age is to be evaluated in proportion as her activities become known. The culture of the imagination is an academic bi-product. This argument of Professor Tarr would, then, as seriously militate against *any* important modification of the lands by denudation as it does against that last stage where the forces of erosion have carried it down to a condition approaching a plain. The same criticism can be applied to his illustration of the slowness of geologic changes taken from the behavior of the Penobscot River in time of summer freshet. It is true that there is but little sediment in the running water of the stream, but does Professor Tarr deny that the neighboring mountain, Katahdin, has been worn out of an enormously greater terrane than that represented in the present mountain-root? We may note, in passing, that in any case the actual work of the Penobscot cannot be gauged by mere observations on a summer freshet; it is in the spring, after the frost has loosened débris from the mountain-sides, that most of the transportation is effected for the year.

2. The second objection referred to is more concrete and withal more scientific; yet it may be met in the same way. Each of many of the greater unconformities in the geologic scale means a stand of the land long enough to remove almost completely a mountainous relief of surpassing magnitude by the self-same process of slow denudation as that characteristic of the lands to-day. Witness the pre-Palæozoic land surface of the crystalline shield of Canada, the wonderfully even surface of the Archæan underlying the fossiliferous rocks of European

Russia or of the plateaus of the Colorado Canyon. A striking example of these buried plains of denudation has recently been seen by the writer in that treasury of physiographic illustrations, the Crimea. As the steamer coasts the southwest shore of the peninsula, one sees a dark line running through the cliffs with almost ideal straightness for many miles; this line represents an old land surface on the well-flexed Jurassic, in which the steeply dipping beds are truncated as nicely as if pared down by a huge knife. Upon them lie the light-tinted Eocene sediments, horizontal, and signifying a perfect case of unconformity. Now we believe that this smoothing of the older terrane in each case is capable of explanation, and as yet only two theories have been advanced to serve the purpose. The first, the theory of subaerial denudation, has by far the weight of evidence in its favor; the second, that of marine denudation (sea-benching on a large scale), is in the highest degree improbable, for reasons that need not concern us here. Both theories alike demand a fairly constant relation of land and sea, not absolute quiescence from up and down movement of the land, but comparatively faint oscillations of the land during a long period. If we are going to explain these fossil land surfaces at all, then we are forced to posit a more or less constant baselevel for each. We have, furthermore, in these same regions positive evidence that they have since been capable of a long-continued absence of important movement of the land with respect to their common baselevel, the level of the sea. As far as the wild Archæan tracts of Canada are known, it seems to be the fact that at least one million square miles of that country have remained above the sea during most of Palæozoic time and all of Mesozoic and Tertiary time. Conversely, from the Cambrian to the Triassic, the Russian terrane was sunk below the sea.

3. We must again join issue with Professor Tarr, when he contends that there are no extensive peneplains of modern date existing on the earth. The Russian Plain, from St. Petersburg eastward and northward, is essentially in this condition; while, considering its vast extent, the whole of the European part of the empire has suffered but a minimum amount of warping from

the original position of the same peneplain. But, granted that there be no recent peneplain at or near the present sea level, it would not prove that such plains have not been formed in past geologic ages. Late Tertiary time has been that of exceptional energy in mountain-building on the lands, and very probably in drowning of parts of the continental ridges in the ocean. Both of these correlated causes might well bring about an important lowering of the sea level simultaneously about all the continents. The result of such movements would be to raise some of these plains above their ideal position near the sea, to tilt others either toward or from the sea, and, possibly, to leave one in about its original attitude with respect to the ocean level.

4. Professor Tarr goes farther and denies that there has yet been adduced evidence that there exist peneplains of ancient date, *i.e.*, those which have been uplifted and are being dissected in a new cycle of geographic development, or those that have been buried in sediments after depression; the peneplain theory is useless because there is no peneplain to need explanation. To establish this doctrine he gives us the results of his study of the uplands of New Jersey and New England.

He finds five hundred feet of difference in the tops of the New Jersey hills, and about as much in "the very even-topped Kittatinny Mountains." "There is a very distinct lack of uniformity in the elevation of the upland crests"; it is truly a distinct lack, but is it, even on the showing of Professor Tarr's figures, sufficient to remove the topographic facet represented in the average level of these higher points from the category of an almost-plain? He tabulates the ranges of elevation on the survey sheets of Connecticut as follows:

Cornwall	1787–1215	feet, a range of 572 feet.
Winsted	1600–1160	" " " 440 "
Granby	1240–720	" " " 520 "
Hartford	lowland.	
Tolland	985–660	" " " 325 "
Woodstock	761–540	" " " 221 "

He concludes that it is more important to emphasize the total range of elevation of the crests in this 91 miles than to

emphasize the fact that in any given sheet the total range is relatively very small and decreases with the decreasing absolute heights of the hills in going from west to east. Is this striking accord of elevations to be ignored in an explanation of Connecticut scenery? Professor Davis has regarded it as indicative of a peneplain of the last geographic cycle, now tilted towards the east and somewhat dissected, especially on the softer rocks, in the present immature stage of a new cycle. It is a theory at once clear, definite, and involving no processes other than those actually illustrated on the earth at the present time. It explains the existing uplands and valleys of the regions under discussion, and, above all, the presence of this otherwise inexplicable topographic facet which is once more established by the foregoing table of Professor Tarr.[1]

A second point that he makes against the New England peneplain shows a disregard of patent facts which it is most difficult to understand in the most superficial survey of New England geography. He writes: "In Maine, New Hampshire, Vermont, western Massachusetts, and the Adirondack region, with similar structure to that of the region above mentioned, and so near them that they must have been subjected to the same general degradation, the lack of uniformity of upland crests is very much more marked." The elevation of the latter "is 2000 to 4000 feet above the sea." Now, so far as the present writer is aware, neither Professor Davis nor any one else has contended that these summits represent any part of the peneplain; they are, on the contrary, stated to be local and regional monadnocks interrupting the general surface of the peneplain for very good reasons. Among the latter is one which has met with contradiction in an expression of the passage just quoted, namely, that there is similarity of "structure"

[1] I should not hesitate to speak of an extensive mountain range as a "peneplain" if it no longer showed a range of elevations greater than 572 feet in a stretch of 91 miles. It is, however, true that the ranges of elevation cited by Professor Tarr are determined from the position of streams which have strongly incised their beds because of the Tertiary uplift. On the other hand, some of the higher points may represent extremely low monadnocks overlooking the peneplain of Professor Davis's definition (range of elevations through 200 or 300 feet) from altitudes of 100 or 200 feet.

between these terranes and that underlying the peneplain. Whether "structure" means "position" alone or "position" plus "texture" (as it manifestly ought not to do), we cannot agree with the statement. The granites, granitites, syenites, and quartz porphyries of Osceola, Tripyramid, the eastern Kearsarge, Red Hill, and the New Hampshire Whiteface, are entirely different in structure and mineralogical characters from the foliated rocks of Massachusetts or even the batholites of coarse porphyritic granite of New Hampshire and Massachusetts, and we believe that no practical worker in the field relations of these areas finds difficulty in putting in similar contrast the Massachusetts foliated rocks and the heavier, more massive gneisses and schists of the White Mountains proper. Is the structure of the Adirondack granite massif "similar" to that of the Berkshire plateau, the structure of Mount Ascutney, Vermont, with its three great stocks of deep-seated intrusives, "similar" to the structure of the surrounding phyllites and gneisses, or that of the granitic Katahdin "similar" to the Calciferous slates through which the granites came?

Professor Tarr goes on to say that he has stood on the "higher" peaks of Maine and looked in vain for any series of peaks that even to the eye appeared uniform in level. For any one to advance this observation as an argument against the New England peneplain seems to us quite incomprehensible. To look for a fairly chosen peneplain sky-line a thousand feet or two thousand feet above the level at which the advocates of the peneplain ask us to find it, and to look for that sky-line in a nest of granitic monadnocks, is hardly likely to be the mode of procedure by which to successfully attack the theory of the peneplain.

He questions any serious lack of "sympathy between the level-topped hills and the rock texture and position." He notes the fact that the soft gneisses and the limestones of New Jersey lie in regions of average lowland, and the hard gneisses underlie areas of greater elevation. This is the sole argument he makes to support this lack of sympathy. He then states, without the shadow of proof, that, "although the rocks are complex in kind and position, they now stand in very general

harmony with topography." In the next paragraph he admits that "the region is a lowered mountain mass, evidently once of a very rugged topography, but now much reduced and traversed by drainage lines of a somewhat mature form, the result of elevation." But that there be or not a lack of sympathy between structure and land-form will evidently depend, among other conditions, upon the degree of the lowering. The make-up of the New England upland certainly indicates the former existence in the district of massifs of flexed rocks at least as imposing from their altitude as the modern Alps (one resulting conclusion from the detailed work of Emerson in western Massachusetts, of Shaler and Woodworth in the faulted and folded region of Narragansett Bay, of Pumpelly, Wolff, and Dale in the Green Mountain axis, to say nothing of the older work of the Hitchcocks and others). Where are the ridges corresponding to the folds of the Boston Basin, or the fault-scarps of Rhode Island or of the Connecticut Valley? It is, in other words, impossible to speak of sympathy between the topography and the structures of New England, when the latter demand displacements of thousands of feet, especially in view of the fact that the valleys and hills of the upland run at all angles to the axes of folds or the lines of fault. There *is* some sympathy between topography and the hardness of the rock-members, but it is only with the extremest rarity that there can be traced any correspondence of structure (position) and the land-form in New England outside of the Narragansett Basin or the Triassic lowland.

The evident adaptation of many of the valleys and broader lowlands of New England to the superior softness of the rocks they cover is just what we should expect to find on any theory of New England topography that recognizes a period of uplift, recent, but long enough ago to allow of the excavation of the valleys to their present levels. This uplift Professor Tarr acknowledges, but claims that "there is no evidence to prove" that this uplift has been differential, that is, that there has been a tilting toward the southeast. If there has been no such tilting, it is necessary, following Professor Tarr, to consider that while the Deerfield has cut its canyon-like valley, and is still

cutting downward with energy, the eastern part of Massachusetts has been lowered to a degree where, in Professor Tarr's words, "there may well have been an approach toward the condition of a local peneplain." That is, the relatively insignificant amount of work necessary to hew out the Deerfield valley must have taken as much time as the wasting to an almost-plain of a coastal belt from twenty to thirty miles broad at least. From his own point of view, Professor Tarr would explain this strong contrast in the rate of cutting by the fact that the coastal region is the locus of river systems with short courses to the sea, and, consequently, great head and erosive power. But how is it that the plateau of western Massachusetts is not similarly worn down by the rivers which have a quick course to the sea *via* the long-opened-up Triassic lowland on the west? (This implication, in the last quotation, that subaerial erosion may produce a peneplain near the coast on the scale permitted by the range of elevations in Massachusetts, seems to be a virtual abandonment of his whole position on the part of Professor Tarr.)

The theory of differential uplift is antecedently probable, and the facts of present geographic form are exactly those that would be expected to result from the elevation of New England at the close of a former complete cycle of denudation. A tilting toward the east and south would give the revived rivers of the northern and western parts of the peneplained region power to etch out of the terrane narrow valleys on the hard rocks and broader valleys on the less resistant ones. The broadening of the valleys would progress as the time allowed, as the area of soft rocks permitted, and as the river was strong. Where the second and third conditions are satisfied, as in the case of the Connecticut, we have a broad open (Triassic) lowland of the new cycle; when the second is not so well fulfilled, the same river gives us a much narrower lowland, that on the "Calciferous mica-schists" of southern and central Vermont.

One of the most strongly emphasized objections of Professor Tarr to the theory of peneplanation is based on the occurrence of monadnocks, or residual hills, on the New England upland. He asks: "Are the monadnock rocks essentially harder than the other hilltops of the neighborhood?" and answers the ques-

tion in the negative on page 363 of the article under review, and in the affirmative on page 369.[1] If an affirmative answer be not possible, there is no possible explanation of these higher crests in the light of our present geological knowledge. Monadnocks like the Blue Hills near Boston, Ascutney Mountain, Chocorua, Katahdin, are made of plutonic rocks, necessarily crystallizing under the pressure of overlying masses of the same lithological character as the rocks now seen in the immediate vicinity of these eruptive centers. The overlying rocks are gone, the surrounding rocks are well beveled down; the stock-rocks stand up as knobs — Why? — because they are harder. If there can be suggested a simpler, more probable explanation, it is high time that geologists should find it out.

It has been my fortune to map geologically one of these typical monadnocks, Mount Ascutney, and, on all sides of it, to meet with striking illustrations of the fact that it stands above the general level solely because it is more resistant to destructive agents. The streams running across the syenites and granitite far up the mountain are slowly cutting their gorges, continued in radial arrangement, across the contacts on all sides. At the contacts there is almost universally an abrupt fall where the streams escape on to the thinly foliated schists or basic intrusives that encircle the main mountain. This exhibition of differential hardness is correlated with an only less important steepening of slope where not the perennial streams, but the general process of wasting and wash, "creep," has developed a sudden fall-off just at the zone of contact of intrusive and country-rock. In the reconnaissance of the mountain this latter slope was used as a rapid means of locating the contact.

Now *these* are the test cases. It is, indeed, difficult to say why the gneissoid and schistose rocks of Mount Monadnock have refused to weather down as rapidly as the similar schists round

[1] On page 363 we read: "I believe that I am correct in saying that there are no very distinct differences between the rocks of the monadnocks and the lower hills, in point of durability." On pages 368 and 369 we have: "There will be a beveling of hilltops where the harder gneissic and granitic rock exists, the stream valleys standing near the base level, and hills of softer strata standing at levels still lower, in which the rock is harder. . . . Can any evidence be adduced to show that New England has ever advanced further in development than this stage?"

about; but, by all the laws of analogy, it is simplest to believe that the same explanation of differential hardness applies here. (I would go so far as to say that, on the basis of direct observation in the field, it is not differential *elevation* that explains the existence of Mount Monadnock.)

Following his criticism of the peneplain theory, Professor Tarr attempts some constructive theorizing on the present relief of such regions as New England and New Jersey. He regards it in each case as a mountainous area in the condition of "full maturity of topography," "reduced mountains, lowered to the stage of full maturity." "By this explanation it is held that the region was never reduced to the peneplain stage, but has always been, as it still is, a mountainous section, though once less mountainous than now, because of the recent uplift." But, disregarding the uplift, is it correct to speak of such relief as that of Massachusetts as characterized by a stage of "mature" dissection? Will the average inhabitant of the upland be flattered in learning that the tract in which he lives ought, by the laws of distribution, to be occupied by a few miserable, impoverished individuals, isolated by a labyrinth of valleys and hills from their fellows? For such is the condition of most of the maturely dissected areas of the earth's surface; the moonshiners of West Virginia eloquently represent one result of mature dissection. Fortunately for the needs of man, a maturely dissected region is almost as rare as one that is characterized by chronic earthquakes of destructive violence. But when, in addition, Professor Tarr states that, by "mature" topography he did not mean even the present relief, but a topography made "more rugged" by the recent uplift, it is all the more difficult to subscribe to his nomenclature of that earlier surface. So far is the Berkshire plateau, for example, from being of "mature" form, made more rugged by uplift, that an unprofessional observer, returning from a walking tour across the plateau, has remarked to me in very definite language that the plateau is "flat," so strong was the impression upon him of the even-topped character of the whole. Yet how likely is the untrained student of land-forms to overlook the existence of a topographic facet, however faintly it may be dissected!

The most valuable part of the paper is that in which Professor Tarr emphasizes the effect of the tree-zone in retarding the progress of denudation and the consequent tendency of the higher summits of a mountain range. Pike's Peak is a good example in point, the rounded slopes below that zone contrasting finely with the serrate spurs of rapidly degrading naked rock far up. Professor Tarr would find in the halting of one peak at the snow-line until overtaken in the downward journey by its neighbors an explanation of the even tops of "mature" mountains, in particular those of New England. But the very rough accordance of levels expected in this ideal scheme, and represented in parts of the Alps and Carpathians, is not in the slightest degree comparable with the New England conditions, nor with the "very even-topped Kittatinny Mountains," referred to in the article. Thus it is impossible to conceive that the New England facet can be accounted for as formed at a vanished tree-zone. Having reached the tree-zone, the forces of denudation then tend to reduce the mountains still further, but now according to the law of soft and hard. Now, since the effective tree-zone may be roughly put at an elevation of between 4000 and 5000 feet in New England, we are as badly off as ever in arriving at a conception of how a nearly plane surface can be produced on the rocks of differing hardness composing the mountains, unless that surface is the result of the beveling down of all the terranes nearly to baselevel. Finally, there are well-established peneplains, such as that on the old rocks of Missouri, where the tree-zone theory cannot avail, because the district was undoubtedly never raised, at any time during the geographical cycle represented, to a height that would bring about the differentiation of a tree-zone. It is an old plateau of horizontal or but gently folded rocks.

Harvard University, December 10, 1898.

A PECULIAR TOAD.

F. L. WASHBURN, A.M.

In 1896 Mr. J. R. Wetherbee, a student in our biological laboratory, was the recipient of a curious specimen, a toad (*Bufo Columbiensis* Baird and Girard) having an extra arm projecting at an angle from the left side just in front of the normal left arm. The species is not uncommon in parts of

Oregon, but the finding of one with a fifth limb is of rare occurrence, possibly unknown hitherto. The abnormal arm was 3 centimeters in length. Apart from this peculiarity the specimen appeared and acted like any other toad, apparently in no way inconvenienced by this extraordinary lavishness of nature. The extra arm was supplied with 7 digits, and, though not provided with an elbow joint, it could be moved and was moved to a slight extent at the proximal joint next the body.

A photograph of this curious animal was taken by the author and is reproduced on the preceding page.

A drawing of the pectoral girdle and fore limbs is reproduced below (Fig. 1). The ulna and radius of the abnormal arm are separate bones, not fused as they are normally; the proximal

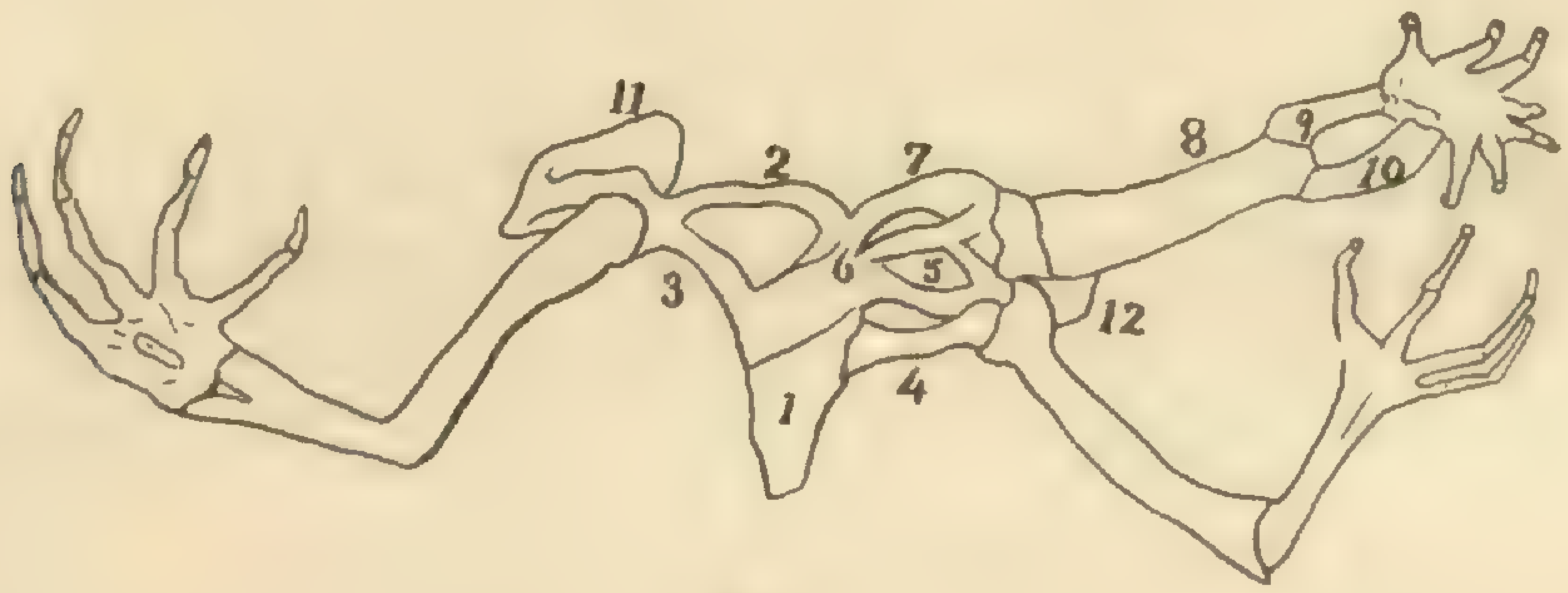

FIG. 1.

end of each is attached to the humerus by intervening cartilage; there are no distinct carpalia, but the metacarpals are joined by cartilage directly to the two long bones, and are grotesquely noduled at the proximal end: 1, sternum; 2, clavicle of right side; 3, coracoid of right side; 4, normal coracoid of left side; 5, normal clavicle of left side; 6 is opposite abnormal coracoid; 7, over abnormal clavicle; 8, humerus of abnormal arm; 9, 10, abnormal radius and ulna; 11 is over scapula and supra scapula of right side; 12 is the left scapula.

The following sketch (Fig. 2) by Mr. Wetherbee, and kindly

FIG. 2.

loaned for this article, was made from his dissection of the superficial muscles of the parts in question. Both Figs. 1 and 2 disclose peculiarities of internal structure which one would expect to find from a consideration of the exterior. There is,

apparently, in connection with the abnormal arm a duplication of some of the muscles of the chest and normal arm.

a = abdominal portion of pectoral muscle.

b = posterior sternal portion of pectoral muscle.

c = anterior sternal portion of pectoral muscle.

f is evidently intended by Mr. Wetherbee to represent the normal sterno-radialis, and *g* is probably the duplicate of *f* for the abnormal arm. The letter *g* is not distinct in the cut; it lies just below *k*.

k, *e*, and *j* I am in some doubt about from Mr. Wetherbee's description, and hesitate to name them. Quoting from his notes: "*k*, origin anterior edge of abnormal arm and a few fibres on sternum, insertion *k'*; *e*, superficial, origin precoracoid, insertion humerus; *j*, attached to dorsal surface of abnormal arm and to under surface of normal arm."

He also says in his notes: "The infra spinalis muscle was nearly twice normal size, and was inserted by two tendons to the fifth arm and [by] one to the normal arm."

The blood system did not offer enough peculiarities to warrant a reproduction of the drawing; the in-going and out-going blood of the abnormal arm passed through extra branches of the subclavian artery and subclavian vein, respectively.

Biological Laboratory,
University of Oregon, Sept. 20, 1898.

HUMAN REMAINS FROM THE TRENTON GRAVELS.

Dr. FRANK RUSSELL.

In the long controversy regarding the age of the implements or "paleoliths" from the Trenton gravels little attention has been given to the human remains from the same beds. Believing that some account of them would prove to be of general interest, I have undertaken[1] their study in the attempt to determine whether or not they resemble the remains of recent Indians of that region. As the Delaware Valley was occupied by the Lenni Lenapé until 1737, the crania found near the surface, at least about Trenton, are, presumably, of members of that tribe.

Material. — The most interesting of these relics is an imperfect calvarium (Fig. 1) found at a depth of twelve feet from the surface in the stratified gravels. It was discovered by a laborer who was leveling the bottom of the pit which had been dug for the gasometer of the Trenton Gas Company. The workman's spade cut away a large portion of the left parietal, which was not recovered. The skull was taken by the foreman in charge of the excavation to a druggist, who displayed it in the window of his store, where it was seen by Dr. Abbott and obtained by him for the Peabody Museum at Cambridge. Both the foreman and the druggist are now dead, so that no statement can be obtained of the circumstances, though diligent inquiries were made at the time by Dr. Abbott. As no one received any compensation for the skull, there was no evident motive for deception. This skull, together with all the specimens described in this paper, is now in the possession of the Peabody Museum of Harvard University. In the report of the curator of the museum, F. W. Putnam, for 1879, we find this statement: "The

[1] With the kind permission of Prof. F. W. Putnam. I have also to thank Dr. C. C. Abbott and Mr. Ernest Volk for information about the position of the specimens.

two human crania received from Dr. Abbott are of particular interest; one probably being the skull of a Shawnee Indian, while the other, which is of entirely different shape, small, long, and very thick, was found in the gravel under such circumstances as to lead to a belief in its very great antiquity."

The calvarium (Fig. 2) from Burlington County, New Jersey, was found by Michael Newbold in 1879, while plowing a field

Fig. 1.

where the "gravel came to the surface." It would have been classed as that of a recent Indian had it not been found in the gravel, not accompanied by the remainder of the skeleton, and had it not resembled the Trenton skull in being low vaulted.

Another calvarium (Fig. 3), exhibited with the two preceding and usually regarded at the Peabody Museum as of the same type, was found in Riverview Cemetery at Trenton in 1887. The workman who found it states that the skull was lying two and one-half to three feet from the surface in clear greenish sand. "The place where it was found is on a knoll, one of the highest

points in the cemetery. No other bones were found with it. There were a few black lines near the skull; they may have been caused by the decayed roots of trees, or bones. No trace of black soil was noticed with the sand. Numerous Indian relics were noticed in the top soil."[1]

Three fragments have been found by Dr. Abbott himself, in the cuts made by the railway in the stratified gravels at Trenton. One of these is a left temporal bone (Fig. 4), the petrous portion of which is broken; and its whole appearance

FIG. 2.

strongly corroborates the statement of the finder, that it was taken from the undisturbed glacial gravels at a depth of thirteen feet.

A portion of the left ramus of a human jaw (Fig. 5) was found by Dr. Abbott at the same locality in 1884. It was lying at a depth of sixteen feet from the surface and appears to have been subjected to rough usage by the gravels. The jaw is that of an individual, having a prominent chin, and exhibits neither primitive nor simian characters.

[1] Statement made recently to Mr. Volk and communicated in a letter dated Dec. 7, 1898.

Still another specimen found by Dr. Abbott at this place is a human tooth, a third molar, an account of which was given in a paper read by him before the Boston Society of Natural History in October, 1882.[1]

In the attempt to identify the single skull, or, assuming that the Burlington and Riverview specimens are also ancient, the three skulls from Trenton, we must necessarily proceed by the

Fig. 3.

comparative method. A number of Indian skeletons have been discovered by Mr. Volk during his excavations upon the Lalor Farm at Trenton, but these specimens are "in boxes and not accessible." The only crania from that region available for comparison with the Trenton skulls are one from West Chester, Penn., in the Delaware Valley, and one from a Delaware peat bog.

I have also included in the table of measurements the averages of a series of five from the stone graves of Tennessee, selected from a large number as being nearly if not quite free

[1] *Proceedings Boston Society of Natural History*, vol. xxii, p. 96.

from artificial deformation. To the northward of the region in question but two crania are available, and these from Central New York, probably those of Indians belonging to the Iro-

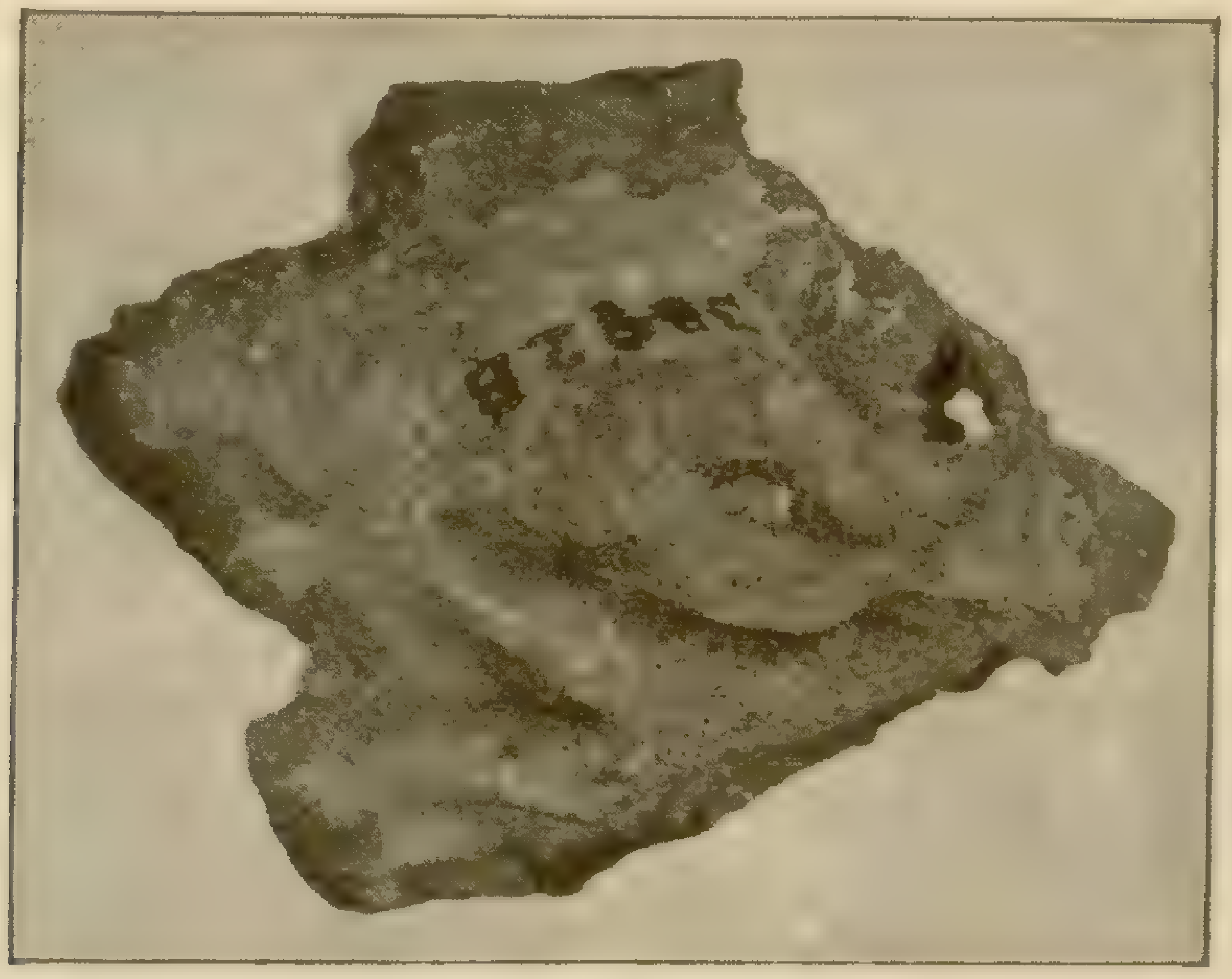

Fig. 4.

quoian stock. From the east a series of Massachusetts crania is taken. For additional comparison a series of skulls from Santa Cruz Island, off the coast of California, is introduced; these have the same cranial index as the average of the three

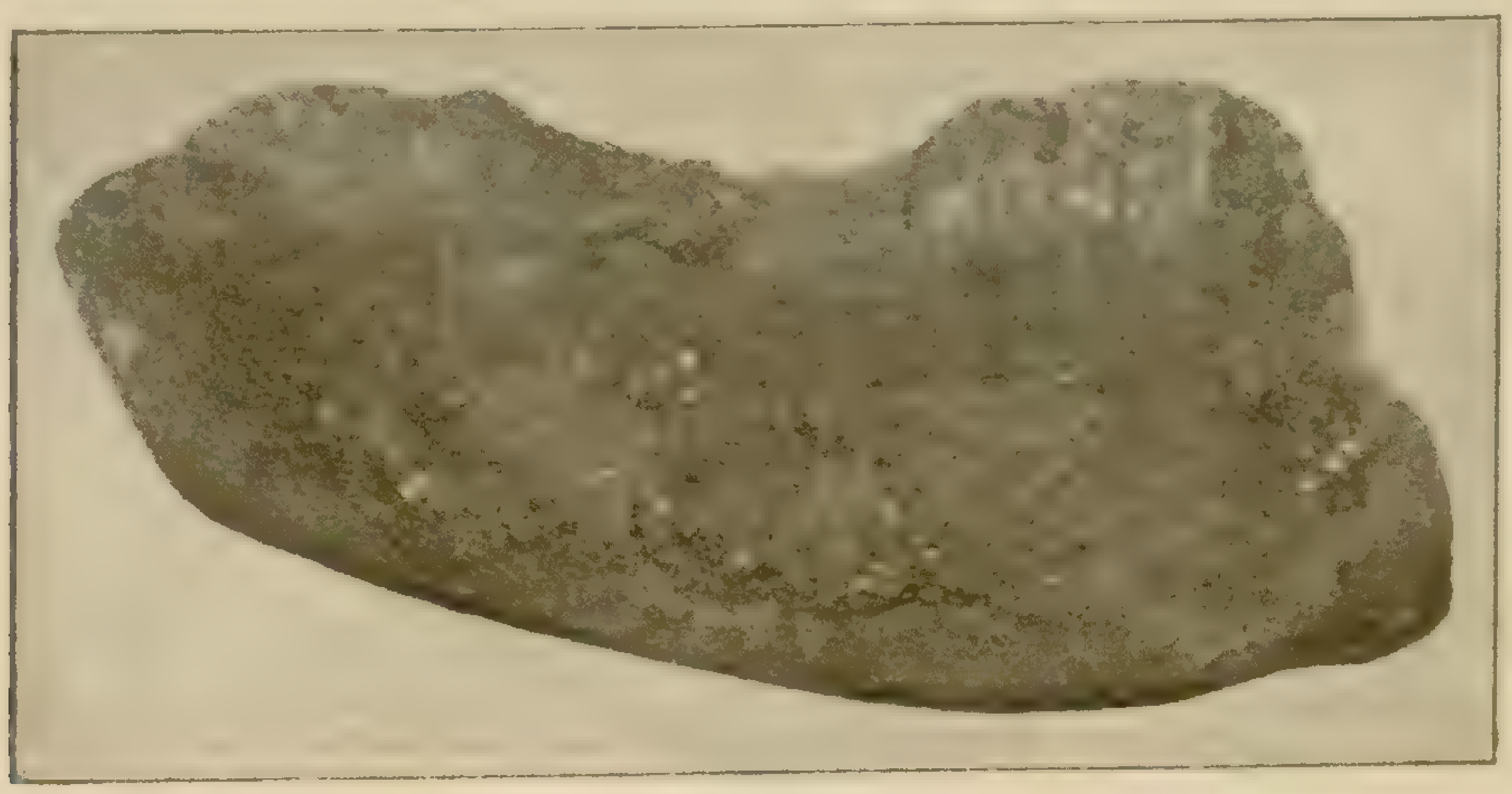

Fig. 5.

from New Jersey. Accounts of most of these have been published by Mr. Lucien Carr, the accuracy of whose measurements is unquestioned; yet I have re-measured all because of some differences in methods of procedure, and in order to eliminate,

as far as possible, the probability of error arising from the personal equation in general.

Discussion of the Measurements. — A general similarity will be noted in the absolute dimensions of the individual crania, except in the case of the male calvarium from Delaware, which is somewhat larger than the others. The condition of the three New Jersey specimens is such that the capacity cannot be gauged by the usual methods. However, the Trenton skull, the smallest, is neither so short, so narrow, nor so low as two adult crania in the Massachusetts series. In all transverse diameters the Trenton skull closely resembles the modern skull from West Chester (Fig. 6), while in the sagittal diameters and the projections from the auricular axis it stands nearer the Burlington and Riverview skulls. The marked brachycephaly

FIG. 6.

of the Burlington skull (Fig. 7) is rare among Algonquian crania, and upon the evidence of this character alone the investigator is inclined to exclude it from further comparison with the Trenton

skull. The Riverview skull (Fig. 8) has an open metopic suture and is both lower and broader than the Trenton specimen.[1]

An exhaustive comparison of the absolute measurements would lead to nothing; the indices are more suggestive. The

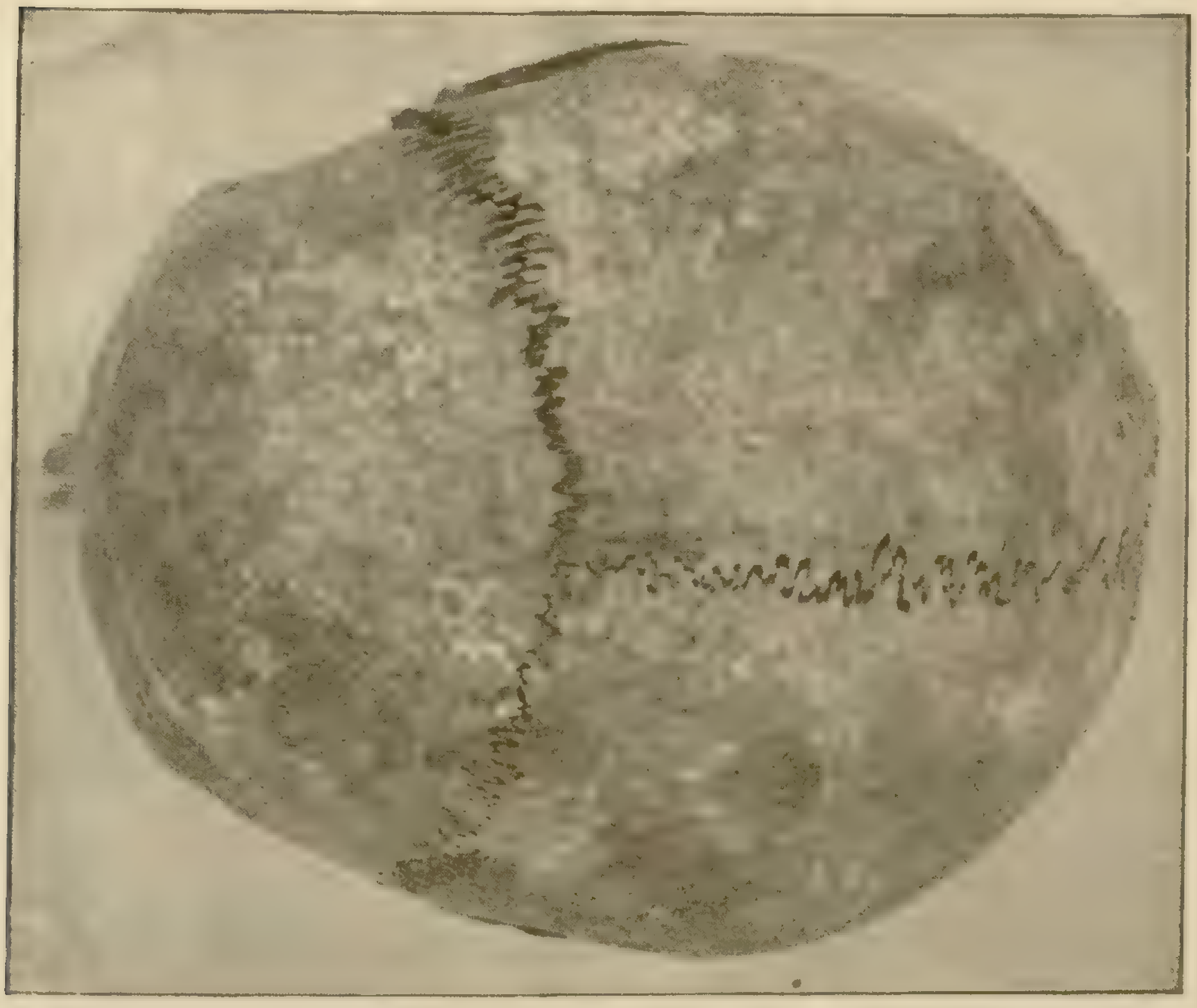

FIG. 7.

cranial index is, of course, the most important of these. In this respect the Trenton skull (Fig. 9) stands near the mean of the whole numbers represented in the table of measurements. The average cranial index of four female crania from Maryland,[2] described by Cope, is 75.1. These crania "are inferably those of Nanticokes,"[3] closely related, of course, to the Lenni Lenapé of the Delaware Valley. The index of the Trenton skull, 77.8, is well within the limits of mesaticephaly and is about the aver-

[1] Harrison Allen has described a Lenni Lenapé metopic cranium having a cranial index of 75, vertical 76, orbital 92, and nasal 53, *Crania from the Mounds of Florida* (p. 408).

[2] Cope, E. D. *Physical Characters of the Skeletons found in the Indian Ossuary on the Choptank Estuary, Maryland* (p. 99).

[3] Mercer, H. C. *Exploration of an Indian Ossuary on the Choptank River, Dorchester County, Maryland* (p. 98).

age of Algonquian female crania; the broken parietal gives it a deceptive appearance of narrowness. Its vertical index (72.5) resembles that of the West Chester skull, and is widely removed from those of the Burlington and Riverview specimens. The relative height is not notably less than that of the Massachusetts series, in which the range of this index is from 67.8 to 8.5. The superior facial index could not be calculated in many cases because of the broken condition of the crania. The naso-malar index, which expresses the degree of projection of the interorbital region, is quite uniform and within the limits of individual variation for the whole series. The racial averages given by Thomas[1] are:

9	Mongols	105.9,	range	105.1	to	106.9
5	Andannanese	107.5	"	105.5	"	108.6
25	West African Negroes	108.5	"	106.1	"	113.3
16	Caucasians	111.1	"	109.1	"	114.2

Sex not stated.

ADDITIONAL EXAMPLES OF AMERICAN CRANIA.

10 ♀	Massachusetts Indians	108.6,	range	105.6	to	111.2
16 ♀	Santa Cruz Island Indians	107.4	"	101.1	"	111.4
5 ♀	Tennessee Indians	108.4	"	106.3	"	110.2
15 ♀	Labrador Eskimos	105.8	"	104.1	"	108.2

The orbital index is higher in the Trenton skull than in the Eastern Algonquins, in only one of which is the index above 90. In the shape of the orbit the New Jersey and West Chester skulls stand apart from the others and fall within the megaseme group. Unfortunately, the nasal index cannot be calculated for the Trenton skull; the West Chester and Riverview crania both have lower nasal indices than the skulls from the region north and west of them. The evidence of the remaining indices is inconclusive and comment is unnecessary.

Condition of the New Jersey Crania. — The sutures of the Trenton skull are obliterated, and its thickness is sufficient to insure its preservation where an ordinary skull would be crushed to fragments. However, it does not present the appearance of having been rolled about for any length of time in the gravels; the left styloid process projects for a distance

[1] Oldfield, Thomas. *Journ. Anth. Inst.*, vol. xiv, p. 333.

of 10 millimeters (Fig. 1), and the surface of the brain-case is almost without a scratch. The lower portion of the face has been broken away in a manner similar to that seen in many skulls from recent graves, and not directly through the stronger parts of the bone, as in the case of the Calaveras skull. The worn appearance of the margins of the orbits and the portions that remain of the zygomatic arches may be ascribed to the

FIG. 8.

vicissitudes of a brief journey in the waters of the Delaware River or Assunpink Creek. Though the surface of the ground where the skull was found is twenty feet above the ordinary level of the Delaware, the locality has been overflowed in recent years, so that existing agencies could have swept skull and gravels into place and buried them beneath succeeding strata of sand and gravels and huge ice-rafted boulders. The length of time that has elapsed since the skull was deposited in the gravels is probably very great, though of course it is not geologically ancient. The presence of the fragments of crania

in the gravel pits along the railway may be accounted for by the same hypothesis advanced by Dr. Abbott to explain the position of the rude implements in that locality. The railroad cutting passes through an old channel of Assunpink Creek, and Dr. Abbott states that "it was *always* along the old creek bed that the chipped argillites were found, along the railroad excavations east of the site of the gas works where the skull was found; and when the excavations continued *beyond the*

Fig. 9.

area of the immediate creek valley they disappeared."[1] The thickness of the Trenton skull is not rare in American crania. The Delaware skull, No. 48,974, furnishes an example close at hand of an even greater thickness.

The Burlington and Riverview skulls are thin and fragile, and their sutures are open (Figs. 7, 8). They are unworn and present no evidence of ever having been moved by flowing water, torrential or otherwise. They do not closely resemble the Trenton skull, though the morphological differences are

[1] In a letter to the writer, December, 1898.

well within the limits of variation of a tribal group. The three skulls are distinguished from those from the regions to the north, east, and west, and are related to the skull from West Chester by their orbital and nasal indices and minor characters.

Conclusion. — From the evidence supplied by the Trenton skulls themselves the conclusion is inevitable that they are of modern Indians, probably of the Lenni Lenapé.

Table of Measurements in Millimeters.

Locality	Briar Hill, St. Lawrence Co., N. Y.	West Chester, Penn.	Cayuga Co., N. Y.	Peat Bog, Del.	Trenton, N. J.	Burlington Co., N. J.	Riverview Cemetery, Trenton, N. J.	Averages. Eleven from Santa Cruz Island, Cal.	Averages. Sixteen from Massachusetts.	Averages. Five from Stone Graves, Tenn.
Catalogue No.	14114	19512	38964	48974	14635	19513	44280	—	—	—
Sex	♀	♀	♀	♂	♀	♀	♀	♀	♀	♀
1. Length, glabello-occipital	180	180	174	193	171	176	185	174.1	178.1	169
2. Breadth	134	130	135	142	133	147	146	136.9	134.5	130.8
3. Minimum frontal breadth	95	93	87	98	94	94	96	89.7	90.9	90
4. Bi-asterial breadth	105	105?	91	119	—	—	—	107.7	106.8	99.5
5. Bi-auricular breadth	118	113	111	123	115	112	118	—	—	—
6. Bi-zygomatic breadth	—	—	124	140	—	123	—	128	127.4	—
7. Naso-malar breadth	107	108	101	115	104	103	105	104.5	102.6	105
8. Bi-malar breadth	99	98	92	108	96?	93	98	96.2	95.5	96.8
9. Bi-maxillary breadth	97	97	91	103	—	92?	93?	94	92.8	93.3
10. Bi-alveolar breadth	61	67	—	70	—	—	57?	63	63.4	65
11. Maxillary length	55	55	57	55	—	—	51	53.8	53.3	54
12. Basi-alveolar length	96	105	103	105	—	—	80	100.8	95.3	97.6
13. Basi-nasal length	93	101	104	105	93	95	84	101.6	92.6	99
14. Basi-bregmatic length	125	132	134	137	124	119	118	123.8	134.5	134.4
15. Basion-obelion	122	130	125	138	124	118	122	121.2	129	126.2
16. Basion-lambda	116	121	115	125	111	111	120	112.4	118.3	112.6
17. Basion-opisthion	—	—	35	42	33	37	37	34.2	34.9	32.3
18. Breadth of foramen magnum	—	—	30	32	26	28?	32	29.3	31.3	28
19. Orbital breadth	41	40 L.	37	42	37	37	36	38.7	39.2	39.2

20. Orbital height	33	37	32	35	35?	36	33	33.8	36.8	34.4
21. Orbital depth	51	51	51	52	50?	48?	50?	48.1	49.7	49
22. Inter-orbital breadth, bi-dacryic	20	23	20	24	24	20	25	20.2	19.3	21.5
23. Nasal height	51	52	50	44	—	—	51	46.4	51	49.4
24. Nasal breadth	26	24	27	30	—	—	25	22.4	25.8	26
25. Palatine length	51	54	54	55	—	—	47	45.9	47.1	48.5
26. Palatine breadth, anterior	22	24	—	27	—	—	23	24.8	25.8	26.8
27. " " posterior	38	43	—	46	—	—	—	40.4	41.6	42.2
28. Naso-alveolar length	73	72	72	63	—	—	69	63.8	68.3	67.8
29. Maximum circumference	506	498	499	550	504?	514	535	495.2	498.4	481.6
30. Supra-occipital arc	400	392?	384	432	353	386	400	388.7	398	380
31. Supra-auricular arc	293?	298	299	312	284?	300	298	282.4	288	292.2
32. Ear to inion	78	—	75	88	83	73	82	—	—	—
33. Ear to vertex	108	117	114	122	107	105	105	—	—	—
34. Ear to glabella	93	94	97	99	85	92	87	—	—	—
35. Ear to orbit	65	67	69	70	60	62	58	—	—	—
36. Facial angle	80°	80°	83°	84°	—	—	84°	78.5	81.9	82°
37. Thickness	—	—	—	8–11	8–10	—	—	—	—	—
Indices.										
38. Cranial	74.4	72.2	77.6	73.6	77.8	83.5	78.9	78.7	74.8	77.4
39. Vertical	69.4	73.3	77	71	72.5	67.6	63.8	71.1	75.9	79.5
40. Superior facial, Broca	—	—	58	45	—	—	—	50.3	—	—
41. Naso-malar	108.1	110.2	109.8	106.5	108.3	110.8	107.1	107.4	108.6	108.4
42. Orbital	80.5	92.5	86.5	83.3	94.6	97.3	91.7	87.7	86.3	87.7
43. Nasal	51	46	54	68.2	—	—	49	48.3	50.6	52.7
44. Maxillary	110.9	121.8	—	127.2	—	—	111.7	119.4	118.6	120.5
45. Palatine	74.5	79.6	—	83.6	—	—	—	88	88.1	87.5
46. Foramen magnum	—	—	85.7	76.2	78.8	75.7	86.5	85.7	86	85.1

EDITORIAL.

THE department of scientific investigation of the United States Fish Commission has awakened to new life under the able supervision of Professor Bumpus, and it aims to aid science in every way not incompatible with the fisheries industry. The laboratory at Woods Holl is to be kept open throughout the year, and students are welcomed there at any time. The facilities of the various stations are placed at the command of those who wish embryological or other material. In the line of research we learn that the department has arrived at the conclusion that the late increase in the number of starfish in the oyster beds of southern New England, and especially in Narragansett Bay, is directly related to the seining of the menhaden and other fishes for the oil and fertilizer factories. These surface feeding fishes formerly destroyed large numbers of starfish eggs and larvæ, but since they have been fished so persistently, the starfish have got the upper hand. It is incumbent upon Rhode Island, if it wishes the best for its oyster industry, to place some restrictions upon the foreign corporation at Tiverton.

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

Report of the Smithsonian Institution.[1] — The report for 1896 contains an account of the "Pueblo Ruins" near Winslow, Arizona, by Dr. J. Walter Fewkes. The exploration of these ruins brought to light a large number of specimens of great interest and value, several of which are depicted in the accompanying illustrations. The character of these plates is noteworthy; they represent the art motives and the symbolism of the ancient Hopi rather than the colors and general appearance of the objects. The small but well-made specimens of turquoise mosaic figured in this paper suggest the more elaborate turquoise-covered objects from ancient Mexico. The chief interest in these investigations arises from their bearing upon the migration legends of the Hopi; we cannot but believe that the examination of the numerous skeletons collected would supplement and enhance the value of Dr. Fewkes's conclusions.

A second paper of anthropological interest is by Professor Hermann Meyer upon the "Bows and Arrows of Central Brazil." This is announced to be an introduction to a larger treatise in preparation. The author based his work upon the ethnographic material contained in the museums of Northern Europe, and deplores the well-known difficulties in the way of ascertaining the exact place of origin of such specimens. A number of illustrations and a map of the central portion of the continent show the distribution of the several types of bows and arrows found in that region. As a preliminary paper this is suggestive and helpful, but with such scanty data the author's deductions regarding the ethnographic character of the Mato Grasso peoples would seem to be liable to considerable modification as the investigation proceeds.

Report of the Anthropological Work in the State Institution for Feeble-Minded Children.[2] — This paper of nearly a hundred

[1] *Annual Report of the Board of Regents of the Smithsonian Institution, 1896.* Washington, Government Printing Office, 1898.

[2] *Forty-Eighth Annual Report of the Managers of the Syracuse State Institution for Feeble-Minded Children, for the year 1898.* Supplement by Dr. Ales Hrdlićka. Syracuse, N. Y., State Printers.

pages embodies the results of an examination of the case-book records of the Syracuse Institution and of the Newark Asylum for feeble-minded women, together with the physical examination of patients with reference to reflexes and structures in the mouth. A comparison is made between the normal birth rate and that in the feeble-minded for the several months of the year. Data are wanting for the state as a whole, but the records of New York City show a decided maximum of births in August, while among the feeble-minded the maxima are in May and December. The proportion of feeble-minded is not materially affected by immigration. The numerical position of the patient in the family is of interest as the proportion of first or only children is above the average. The etiological factors receive careful consideration, and in his concluding remarks the author advocates the employment of men for the purpose of gathering information regarding the history of each individual admitted to these institutions. There can be no doubt but that the accumulation of such statistics would contribute toward the amelioration of the condition of these unfortunates, and possibly to legislation that would remove in some degree the "varied and numerous" causes of the mentally defective. A careful study of this class will also show its intimate relation to the criminal and other abnormal classes: "it will demonstrate the fact that the feeble-minded are simply a link in the great chain of the degenerate class and not an isolated class by itself."

Anthropological Notes. — In the November number of the *American Anthropologist* is published an article entitled "Study of the Normal Tibia," by Dr. Ales Hrdlička, which gives the results of his examination of over 2000 normal adult bones. In addition to the study of the degree of variation in the individual, between the sexes, and in different races, the form of the shaft at the middle was investigated and classified in six more or less evident groups. A series of casts of these types must prove to be of great value to instructors in somatology; it is to be hoped that Dr. Hrdlička will add to the comparative value of the series by a further study of the tibia of the anthropoid apes.

In the November number of the same journal appears an abstract of a paper read before the American Association for the Advancement of Science upon the "Physical Differences between White and Colored Children." The paper is too much condensed for the reviewer to make a satisfactory abstract. However, the general con-

clusions are that the "white children present more diversity, negro children more uniformity, in all their normal physical characters."

The *American Antiquarian* for the year 1899 will contain a list of accessions to, and of the specimens available for exchange in, the anthropological museums of America. This novel feature commends itself to the attention of curators. The appearance of *Antiquarian* would be greatly improved by more careful proof reading.

FRANK RUSSELL.

ZOOLOGY.

Dimorphism in Crepidula. — An interesting instance of environmental and sexual dimorphism is described by Prof. E. G. Conklin[1] in the sedentary gasteropod Crepidula. In *C. convexa* there are marked local varieties depending upon the immediate environment; for example, when found upon the shells of Illyonassa or Littorina it is deeply convex and darkly pigmented, but on oyster shells it is very much flatter and lighter in color. Also among the larger species, *C. fornicata* and *plana*, marked differences in the form of the shell occur, which are due to the nature of the substratum to which they are attached. These irregularities in form are not inherited and are cited as examples of "environmental polymorphism." Dimorphism in *Crepidula plana* is exhibited by the occurrence of a dwarf form in addition to the normal one. The latter is found inside of dead shells of Neverita inhabited by the large hermit crab *Eupagurus bernhardus*, while the dwarf is found in the smaller shells of Illyonassa and Littorina, inhabited by the little hermit *Eupagurus longicarpus*. The disproportion between the normal and dwarf forms is considerable, the former being about thirteen times as large as the latter, as was determined by measurement of body volumes. Age and sexual maturity are attained in the dwarf as in the normal type. All of the organs of the body are reduced in size in about the same proportion, but the cell size in homologous organs of the two forms, including the ova and embryos, is constant. There is thus a smaller number of cells present in the various organs and also in the entire body of the dwarf than in the giant. The dwarfed form is correlated with the small size of the shell in which

[1] Conklin, E. G. Environmental and Sexual Dimorphism in Crepidula, *Proc. Acad. Nat. Sci.*, Philadelphia (1898), pp. 435–444, Pls. XXI–XXIII.

it has found lodgment, but some other factor — as yet undiscovered — than diminished supply of food and of oxygen, reduction of locomotion, or limitation of growth by pressure, is involved in its production. Whatever the cause, it operates by stopping cell growth and division. The dwarfs are not a permanent race, but are constantly recruited from the young of the giants. A few specimens have been found whose shell structure indicates the growth of a typical form from the dwarf condition in consequence of a change to a more roomy home. The dwarfs are what they are by reason of external conditions and not of inheritance. They present a "physiological variety" in which the shape and size of the body, as well as the number of cells in the entire organism, are modified by the direct action of the environment. There is no evidence that these modifications have become heritable. Sexual dimorphism is also well marked in *C. plana*, the average female being about fifteen times as large as the average male. As in the case of the dwarfs, the smaller size is due to the smaller number of cells in the body. Measurements of individual cells of the intestine, stomach, liver, kidney, muscles, and epithelium show that cell size remains the same in the male and female. Whatever the ultimate cause of the smaller size of the male, it operates, as in the dwarf, by causing a cessation of cell growth and division.

C. A. K.

British Entomostraca. — The natural history of the fresh-water Entomostraca of Epping Forest, a woodland tract of 35,000 acres, is given by Mr. D. J. Scourfield,[1] from observations extending through a number of years. The author records 102 species, the most complete local list hitherto published for the British Isles, from which a total of 190 species has been reported. One American form, *Ceriodaphnia scitula* Herrick, and several continental species are reported for the first time from this region. The cosmopolitan distribution of this group is further emphasized by the fact that, with one or two doubtful exceptions, all British species occur in continental Europe, and most of them have been found in North America, and not a few in South America, South Africa, Australia, and New Zealand. On the other hand, districts of limited extent, with characteristic physical features, ofttimes exhibit great differences in their Entomostracan fauna. Hydrological rather than climatic factors

[1] Scourfield, D. J. The Entomostraca of Epping Forest, with some general remarks on the group, *The Essex Naturalist*, vol. x (1898), pp. 193–210, 259–274, 313–334.

determine to a large extent the distribution of this group. The local and seasonal occurrence of each species is given in tabulated form. The Cladocera reach their maximum development, as regards species, in September, and their minimum in January. The Ostracoda exhibit two maxima in March and in September, the latter being more marked, and two minima in August and in January. The Copepoda exhibit but a slight variation in the number of species during the year, though there is some suggestion of maxima and minima similar to those detected among the Ostracoda. The seasonal distribution of males and ephippial females of the Cladocera is given for 34 species. In this group, considered as a whole, there are two seasons of sexual activity, the first reaching a maximum in May and affecting only 10 species, and the second extending throughout the autumn months, culminating in October, and affecting 30 species. Thus in the majority of the species the period of sexual activity is confined to the autumn months, though a small number is affected during both seasons, and a few exhibit but a single annual period in the spring. In only a single species, *Daphnia longispina*, does sexual reproduction continue from May to October. Colonies of a given species found in different aquatic habitats may present marked differences in sexual activity, the size of the body of water seeming to be correlated with the variations. Thus males and ephippial females of *Simocephalus vetulus* have been found in the spring only, in tiny pools and ditches, and again in the fall in bodies of water of slightly larger size, while no trace of either sexual form was observed in a larger pond examined repeatedly during a period of three years. The author is inclined to attribute these differences to the direct action of the environment.

A second paper[1] by the same author deals with the biology of a common water-flea in an interesting way. A respiratory function is assigned to the anal cæcum, a thin-walled triangular sac, with glandular cells in the dorsal wall. It is constantly dilating and contracting, and produces a circulation of water that suggests its respiratory function. As in the Cladocera generally, parthenogenesis prevails with alternating periods of sexual activity. The sexually mature female produces the so-called winter or resting eggs, which, unlike the parthenogenetic or summer eggs, require fertilization in order to develop. The ephippium, which carries the resting egg, is formed in Chydorus from the cast-off shell, which is somewhat thickened,

[1] Scourfield, D. J. Chydorus sphæricus, *The Annual of Microscopy* (1898), pp. 62–67, 1 plate.

especially along the posterior margin. The author suggests the name proto-ephippium for this primitive protective covering of the resting egg. This structure is formed quite independently of fertilization, but before the resting eggs leave the ovaries and are transferred to the ephippium it is necessary that they be fertilized. In the absence of the male the empty ephippium is cast off and resting egg retained. If fertilization does not ensue, this process may be repeated several times in succession, as Weismann has already shown for the larger Cladocera. Some of the secondary sexual characters of the male, as, for example, the form of the intromittent post-abdomen, are not assumed until the last molt preceding the adult condition, the structure preceding this molt being of the female type. Attention is called to the cosmopolitan distribution of the species, and to its preference for small bodies of water rich in vegetation. It is, however, not infrequently found in our largest American lakes. Like some other Cladocera, Chydorus exhibit two periods of sexual activity in each year, one in April and May, the other in November and December; the former is the more important, and affects only those individuals found in small ponds likely to be dried up during the summer, while the latter is confined to colonies in larger bodies of water. It seems probable that some colonies may never have a sexual period at all; at least some large ponds most thoroughly examined never once yielded a male or an ephippial female.

C. A. K.

Rotifers of the Leman. — The first part of a superbly illustrated monograph of the rotiferan fauna of this Swiss lake and its neighborhood has been published by Dr. Weber.[1] Owing to the absence of swamps and small bodies of water in this alpine environment the number of species recorded is not so great as in England or in Germany, though a very extensive list is presented. Each species is briefly described, the synonymy and the bibliography are given, and figures, often in natural colors, are liberally provided. The males and resting eggs are illustrated in some instances. We regret the absence of references to several important American lists in the bibliographies of the various species. American workers on this group will, however, find the paper of much interest, as many of the species figured are abundant in this country. C. A. K.

[1] Weber, E. F. Faune rotatorienne du basin du Léman, *Revue Suisse de Zool.*, tome v (1898), pp. 263–354, Pls. X–XV.

Classification of the Centropagidæ.[1] — In two recent papers Mr. F. W. Schacht has given us a revision of the North American species of this family of Copepoda. On account of the widespread interest in this group among students of organisms in potable water, and of the food of fresh-water fishes, we reproduce here in tabular form the criteria for distinguishing the family and also its constituent genera.

a_1. Division of the body into cephalothorax and abdomen between the thoracic segment bearing the fifth pair of feet and the segment bearing the genital apertures. GYMNOPLEA.

b_1. In male: Anterior antennæ symmetrical or nearly so; and its secondary sexual characters not confined to peculiarities in structure of trunk, the antennæ, the fifth pair of feet, and the abdomen. Marine. AMPHASKANDRIA.

b_2. In male: Anterior antennæ unsymmetrical and secondary sexual characters generally confined to points enumerated above in (b_1). HETERARTHRANDRIA.

c_1. Rostrum present.

d_1. In female abdomen 3 or fewer segments; antennæ with 24 or fewer joints. Male with inner ramus of fifth feet rarely rudimentary. Marine. Family *Pontellidæ*.

d_2. In female abdomen never fewer than 3 segments; antennæ never fewer than 24 segments. In male, fifth pair feet are grasping organs. Family *Centropagidæ*.

c_2. Rostrum wanting. Family *Candacidæ*.

a_2. Division of the body into anterior and posterior parts in front of last (fifth) thoracic segment. PODOPLEA.

Subdivisions of the family Centropagidæ.

a_1. Thorax 6-jointed. Subfamily CENTROPAGINA.

a_2. Thorax 5-jointed.

b_1. Fifth pair feet degenerate; inner ramus, 0–1 jointed; outer ramus, 1–3 jointed. Abdomen of ♀, 3-jointed. Subfamily TEMORINA.

[1] Schacht, F. W. The North American Species of Diaptomus, *Bull. Ill. State Lab. Nat. Hist.*, vol. v (1897), Art. 3, pp. 97–208, Pls. XXI–XXXV. The North American Centropagidæ belonging to the Genera Osphranticum, Limnocalanus, and Epischura, *Bull. Ill. State Lab. Nat. Hist.*, vol. v (1898), Art. 4, pp. 225–269.

c_1. Furca with 3 large terminal setæ to each ramus.
Genus *Epischura*.

c_2. Furca with 4 large terminal setæ to each ramus; Inner ramus, legs 2–4, 3-jointed.

d_1. Inner ramus first pair legs, 2-jointed.
Genus *Diaptomus*.

d_2. Inner ramus first pair legs, 3-jointed.

e_1. Fifth pair legs of ♀ with *spines* on inner side of last joint of outer ramus. In male, outer ramus of fifth leg, 2-jointed on left side; 3-jointed on right side. Genus *Osphranticum*.

e_2. Fifth pair of legs of ♀ with long, plumose hairs on inner side of last joint of outer ramus. In male, both outer rami of fifth pair of legs 2-jointed. Genus *Limnocalanus*.

b_2. In female, abdomen 4-jointed and fifth pair of feet with 3-jointed outer ramus and 2–3 jointed inner ramus. In male, fifth pair of feet subchelate.
Subfamily LEUCKARTIINA.

b_3. In female, abdomen 3- or 4-jointed. The fifth pair of legs has a 3-jointed outer ramus and a 1–3 jointed inner ramus: chetæ undeveloped or wanting in male.
Subfamily HETEROCHAETINA.

A New Rhizopod Parasite in Man.—Professor Ijima[1] has described a new species of Rhizopod, *Amœbæ miurai*, parasitic on the human being. The patient in whom these parasites were found was a young woman suffering from abdominal tumors and an ascites-like accumulation of fluid in the abdominal cavity. She finally died of peritonitis and pleuritis endotheliomatosa. The amœbæ were found in abundance in the fluids of the peritoneal and pleural cavities as well as in the hemorrhagic discharges from the intestine. As many of the amœbæ in the abdominal fluid were dead, and as they died rapidly when kept in this fluid at the temperature of the body, it was suspected that the abdominal fluid was not a natural habitat. The living organisms were spherical or ellipsoidal in form, with a diameter from 15μ to 38μ, and had at one pole a small villous knob. Specimens

[1] Ijima, I. On a New Rhizopod Parasite of Man, *Annotationes Zoologicæ Japonenses*, vol. ii (October, 1898), p. 86.

with two or three nuclei were as frequent in occurrence as those with only one nucleus. Most specimens exhibited two or more large vacuoles. Their movements were at most sluggish. G. H. P.

American Fishes. — The second part of Jordan and Evermann's comprehensive work on the *Fishes of North and Middle America* is just issued (Oct. 3, 1898) from the Government Printing Office. This volume of 943 pages contains detailed descriptions of 1883 species of fishes. The Sparoid, Sciænoid, Labroid, and Cottoid families and their allies make up the bulk of the present volume.

The third part of the catalogue of *The Fishes of North and Middle America* appeared about November 25. This concludes the text of the work, the remaining fourth part being devoted to plates and to a recapitulatory Check List. The three volumes, which are continuously paged, contain 3136 pages; 3127 species are described in detail, these being arranged in 1077 genera. The large number of genera recognized is in accord with the views of Dr. Gill and Dr. Bleeker, which other ichthyologists were slow in accepting. There is no doubt, however, that the convenience of the systematic zoologist is best met by the recognition of every tangible and constant structural difference as having value for generic distinction.

The four volumes constitute *Bulletin 47 of the United States National Museum.* D. S. J.

Fauna and Flora of the Catskill Mountains.[1] — This paper contains a list of 58 trees and shrubs collected in the valleys of Schoharie Creek and Upper Katerskill and the surrounding mountains; 9 gastropods and a Sphærium, mostly from the Creek; Cambanes bartoni, 8 fishes, 8 batrachians, 2 snakes, and a fairly complete list of the mammals with copious notes.

Mr. W. P. Pycraft will study the megapodes collected by the Willey Expedition. Materials for the embryology were obtained.

The article by Ameghino upon an existing species of Mylodon (*Neomylodon listai*) is reproduced in *Natural Science* for November. The evidence is a piece of skin from Patagonia, the outer surface of which presents a continuous, not scaly, epidermis, covered with stiff, reddish hair about two inches in length. In the deeper layer of the

[1] Mears, L. A. Notes on the Mammals of the Catskill Mountains, New York, with General Remarks on the Fauna and Flora of the Region, *Proc. U. S. Nat. Mus.*, vol. xxi, pp. 341–360.

skin are dermal ossicles similar to but somewhat smaller than those of the extinct Mylodons. The only white person to see the animal alive was the traveler, the late Ramon Lista, who described it as about the same shape and size as the Indian pangolin.

Professor Poteat has recently shown that Leidy's genus Ouramœba is really Amœba plus mycelial hyphæ.

BOTANY.

California Plants in their Homes.[1] — This little book of Mrs. Davidson has more successfully brought together the choicest spirit of the ecology and physiology of plants than any other which has come the way of the writer of this notice. Being made for children, it has from this very fact all the more to teach the adult devotee of the science. In some sixteen chapters we are introduced to many kinds of plants and come away with more than a bowing acquaintance. We are introduced to many of the innermost mysteries of their lives and learn their innocent and contriving ways of obtaining for themselves the coveted advantages over their neighbors. While the book is written so that it may be used as a reader, the "supplement for the use of teachers," together with the style of the writing, make it one of the most possible of laboratory books for the younger student; in fact, the temptation to follow out the suggestions of the author to do this and to do that is so fascinating and so easy that it needs only the chance, supplied by the teacher, to be done. The book is, unfortunately, Californian only, but the lesson to teachers is as wide as the subject taught. Our text-books run now to physiology and ecology, but simply as classifications of physiological and ecological facts, from the consideration of which the poor student comes away knowing well that certain things are so, but with little notion of the reason why the teacher has been to such extraordinary pains to make him aware of it. But Mrs. Davidson is a teacher, — a teacher of teachers in fact, — and has realized the folly of thinking that we really get away from the evils of the old systematic teaching in botany by changing simply the subject-matter without changing the method and point of view.

While confessedly an elementary book, this is to be compared

[1] Davidson, Alice Merritt. *A Botanical Reader for Children.* Los Angeles, B. R. Baumgardt & Co.

with many of the books which have been issued for students of a higher grade than those technically for children. The facts brought forward are those usually taught only in books for the higher grades, but they are presented in such a way as to be equally intelligible to "children," with the farther advantage that the significance of the detail is never lost sight of — an advantage inestimable in its results. In the headings to the chapters, too, the author has displayed great ingenuity, and the results are not open to such criticism as may be directed toward those of some popular books and articles on botanical subjects.

The most unsatisfactory features of the book are the illustrations. They are too coarse to convey the idea desired in most cases, and the grace and delicacy of most of the plants figured have been lost entirely.

We feel that the teacher in California who attempts to realize from "nature study" in the lower grades that which is hoped for from it, will find a way pointed out by this book which is both clear and certain, and that the teachers in other states will realize their need of a similar book and find much assistance by using it and adapting it to their local needs.

W. A. SETCHELL.

Van Tieghem's Eléments de Botanique.[1] — While the first volume of this text-book, as would be expected from the author's many important contributions to vegetable anatomy and morphology, presents a clear and sound statement of this part of botany, the second volume, in the present edition, merits special mention as being the first readily accessible synopsis of the vegetable kingdom in which the dicotyledonous flowering plants are classified according to their seed and ovule structure along the line laid down by Professor Van Tieghem in a series of articles published some two years ago.[2]

Excluding the Nymphæaceæ, which, with the Gramineæ, he places in a class considered as being exactly intermediate between the Monocotyledons and Dicotyledons, the author divides the latter into two subclasses, Insemineæ and Semineæ, the first destitute of detachable seeds at maturity of the fruit, and the second bearing seeds. The first of these is then divided into groups marked by the presence or absence of transient ovules (which, when present, are

[1] Van Tieghem, Ph. *Eléments de Botanique.* Troisième édition. Paris, Masson et Cie., 1898. 2 vols., 12 mo. i. Botanique générale. ii. Botanique spéciale.

[2] Van Tieghem. Sur les Phanérogames sans graines, formant le groupe des Inséminées, *Comptes Rend.* **124**: 22 mars–3 mai, 1897.

homologized with carpellary leaflets, the embryo sac otherwise originating in the tissues of the simple carpel), and both subclasses are further subdivided according to the number and character of their ovule coats, while the ultimate grouping of families, though to a certain extent dictated by grosser characters, is influenced largely by the results reached in late years by the students of systematic plant anatomy.

As might be expected, the sequence of families is greatly modified from that which represents the conclusions of the English and German schools, though of the two it naturally conforms more closely to the latter, by which a more consistent effort has been made to represent phylogenetic affinities as indicated by anatomical as well as more obvious structure.

Whatever may be the general verdict on the new basis of primary classification and its present exemplification, — and it is likely to find more opponents than supporters, — the author is to be congratulated on having presented his views in a suggestive and convenient form for the guidance of future investigators; and the attempts which are sure to be made both to strengthen and overthrow it by the histological taxonomists can but result in laying further foundation stones for a truly natural system of the flowering plants. T.

Are Bacteria Fungi? — In *Centralblatt f. Bakteriologie*, etc., 2te. Abt., Bd. iii, Nos. 11 and 12, Dr. Johan-Olsen argues that bacteria are simply one stage in the development of fungi and supports his text, Zur Pleomorphismusfrage, with two well-drawn plates. Unfortunately, some of his most striking examples are drawn from species of Oospora which mycologists for many years have classed as fungi, and whose only claim to be classed as bacteria is the fact that when their extremely tenuous hyphæ break up into conidia, or oidia, the latter closely resemble rod-shaped bacteria in size and form. These conidia, however, grow into genuine branched mycelia. Some of the other cases which he cites, *e.g.*, branched tubercle and diphtheria bacilli, may well be involution forms, as Dr. Migula has suggested, since they are usually found only in old cultures, sparingly, and under conditions unfavorable to the organism. More difficult to explain is his account of the change of the mycelium of *Dematium casei* into bacteria bearing endospores, the germination of which spores he succeeded in witnessing. Possibly Dr. Ol. Johan-Olsen was working with mixed cultures. Much is said of Dr. Brefeld's *System*, but if Dr. Johan-Olsen's culture methods are not a very decided improve-

ment on those of his master, which have been described to me in recent years by a number of people who have studied at Münster, and which are certainly very crude, then we are fully warranted in calling in question the results. One is the more inclined to do this because in another paragraph we are told that: "Almost all bacteria, which I have had in cultivation in recent years, form a branched mycelium in course of time, especially all bacilli." We are also rendered suspicious by the statement that species of Aspergillus and Mucor may appear in the form of amœba. It is possible, of course, that bacteria are only "incompletely known fungi," but up to this time the evidence is certainly not very conclusive, and to the writer it seems not at all improbable that they may have had quite a different origin — at least many of them.

ERWIN F. SMITH.

Dr. Bolander. — In *Erythea* for October, 1898, Willis L. Jepson writes interestingly of Dr. Henry N. Bolander, botanical explorer, who died in Portland, Oregon, Aug. 28, 1897. He was born in Germany, but most of his life was spent in Ohio and on the Pacific coast. He was educated for a clergyman, but through the influence of Leo Lesquereux his energies were turned into scientific channels. The article is accompanied by a half-tone picture of the botanist. Thirty-seven species of flowering plants were named after Dr. Bolander.

E. F. S.

The Costa Rica Flora. — The second volume of the *Primitiæ Floræ Costaricensis*, begun by Pittier and Durand, is continued by the first-named author alone. But Part I of this volume, concerned with the Polypetalæ, is from the pen of Capt. John Donnell Smith, whose work on the flora of Guatemala is everywhere well known. As might be expected, several species are here described for the first time. Descriptions of a number of species previously published in the *Botanical Gazette* are reprinted, for obvious reasons.

Urban's West Indian Flora.[1] — The first fascicle of this work, with which Dr. Urban has been known to be occupied for some years past, reaches page 192, and is entirely devoted to a botanical bibliography of the West Indies. The botanical treatment itself is awaited with much eagerness.

T.

[1] Urban, I. Symbolæ Antillanæ seu fundamenta floræ Indiæ occidentalis, 1. 1. Berolini, Fratres Borntraeger, 1898.

Bailey's Evolution of our Native Fruits.[1] — Though Professor Bailey is a horticulturist and commonly writes for horticulturists, he is well known to botanists as an accomplished botanist. To say that the nine chapters comprised in the present book are devoted to the rise of the American grape, the strange history of the mulberries, the evolution of American plums and cherries, the native apples, the origin of American raspberry-growing, evolution of blackberry and dewberry culture, various types of berry-like fruits, various types of tree fruits, and general remarks on the improvement of our native fruits, tells little of the wealth of detail that it contains. Group after group is monographed, and people in search of disentangled snarls of nomenclatural detail need seek little further than the present work for models of conservative upheaval when upheaval becomes necessary. As to the horticultural side of the book, little need be said: it was written for horticulturists.

T.

Poisonous Grains. — It has long been believed that the fruit of *Lolium temulentum* is poisonous, and chemists have had something to say about its toxic principles. In the *Journal de Botanique* for August, M. Guérin publishes an article embodying the results of a study made at the École supérieure de pharmacie of Paris, in which he records the constant occurrence of fungal hyphæ in the nucellus of the ovule and the layer of the caryopsis lying between the aleurone layer and the hyaline portion of the wall. These hyphæ, which appear not to have been identified with any fruiting form, are referred to as, perhaps, the cause of the toxicity of the Loliums in which they occur (*L. temulentum*, *L. arvense*, and *L. linicola*), and they are stated not to have been found in *L. Italicum*, and only once in *L. perenne*. The fungus is compared with *Endoconidium temulentum*, Pril. & Delacr., found in diseased grain of the rye, and believed to be the cause of some of the cases of poisoning attributed to that grain, though it is believed to differ from the fungus named, and the conclusion is reached that, unlike this species and Claviceps, it lives in the maturing grain symbiotically rather than as a parasite.

Botanical Notes. — The issue of *Möller's Deutsche Gärtner-Zeitung* of October 22 may be called a Clematis number. It is well illustrated and contains a number of articles on the cultivated forms of this attractive genus by well-known writers.

[1] Bailey, L. H. *Sketch of the Evolution of our Native Fruits.* New York, The Macmillan Company, 1898. 8vo, xiii + 472 pp., 125 ff.

Ranunculus Andersonii Gray is made the type of a new genus, Beckwithia, by Jepson, in the October number of *Erythea*. Unfortunately, the fact that the two are identical was not discovered soon enough to prevent the one species from appearing on the plate as *B. Andersonii*, and in the text as *B. Austinæ*.

Anton Pestalozzi's revision of the Capparidaceous genus Boscia, reprinted from the *Bulletin* of the Boissier Herbarium, forms No. 7 of the "Mittheilungen aus dem botanischen Museum der Universität Zürich."

The acaulescent violets of the eastern states are the subject of further observations by C. L. Pollard, in the *Botanical Gazette* for November. Twenty-seven species of this type are now distinguished in the key, but even then the author adds that he fully realizes "the futility of constructing any key in the hope that it will afford conclusive determinations of every unusual form." "Habit as well as habitat, the texture of the herbage, color of the flowers, position of the cleistogenes, nervation, shape and degrees of pubescence of the leaves, nature of the surrounding vegetation," are all taken into consideration in the separation of species for which herbarium material is said to be absolutely worthless unless one is fortified by previous familiarity with the growing plant.

Hydrophyllum tenuipes is the name given by Heller in the *Bulletin of the Torrey Club* for November to a plant from the state of Washington.

The hybrid between *Lobelia syphilitica* and *L. cardinalis*, which sometimes occurs spontaneously in this country, appears to have been produced in cultivation in France, and to have been again crossed on *L. cardinalis* (*Annales Soc. Bot. de Lyon.* **22**: 8).

Part III of Professor Comes's memoir on tobacco [1] is a classified account of the introduction, cultivation, and use of tobacco in Asia and Oceania.

M. C. de Candolle contributes a paper entitled "Piperaceæ Bolivianæ" to the *Bulletin of the Torrey Botanical Club* for November. Two new species of Piper and ten of Peperomia are described.

Actinidia Kolomicta, a climbing plant, the foliage of which is quite as brilliantly colored as that of the commonly cultivated and popular Acalyphas, is figured in color in *Die Gartenwelt* of November 6.

[1] Comes, O. Del tabacco. Storia, geografia, statistica, speciografia, agrologiæ patologia. III. Napoli, 1898. (*Atti R. Ist. d'Incorrag. di Napoli.*)

An interesting paper is that by Rowlee and Hastings in the *Botanical Gazette* for November, on the seeds and seedlings of some Amentiferæ.

Septal nectaries, quite common in several of the larger families of Monocotyledons, are now noted by Van Tieghem for *Cneorum tricoccum*, for which it is proposed to create the new combination *Chamælea pulverulenta* (Vent.). (*Bull. Muséum d'Hist. Nat. Paris*, **1898**: 241).

Luzula campestris and related species form the subject of a neat little brochure, with a good plate, reprinted by Buchenau from the *Oesterreichische Botanische Zeitschrift* of 1898.

The Cyperaceæ of British India have been tabulated by C. B. Clarke in the *Journal of the Linnæan Society*, *Botany*, No. 235, with reference to their geographical distribution. Eleven areas are recognized from this point of view. The paper is thus virtually an appendix to the *Flora of British India* of Sir Joseph Hooker.

Dr. Elliott Coues, in the *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1898, Part II, publishes a critical article on the localities for the plants of Lewis and Clark's herbarium, a list of which, apparently rather inaccurate in some respects, was some time ago published by Mr. Meehan.

"A Few Notes on Canadian Plant-lore," by Carrie M. Derick, and "A Review of Canadian Botany from 1800 to 1895," by D. P. Penhallow, are the titles of Nos. 6 and 7 of the *Papers from the Department of Botany of McGill University*, reprinted, respectively, from the *Canadian Record of Science* and the *Transactions of the Royal Society of Canada.*

From its title, the *Queensland Agricultural Journal* would not be turned to by the systematic botanist, but its current issues contain a goodly number of descriptions of new species of Australian and Papuan plants by F. Manson Bailey, the colonial botanist of Queensland.

Science, of November 18, contains a preliminary paper on the fauna and flora about Coldspring Harbor, L. I., by Professor Davenport, and an article by Dr. Mead on an unusually abundant occurrence of a species of Peridinium in the waters of Narragansett Bay last summer, giving an intense red color and a very disagreeable odor to the water, and killing many fish and crustacea.

The last part of the *Wissenschaftliche Meeresuntersuchungen* of the Kommission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel is largely occupied by phycological plankton studies.

Heft 5 of *Hedwigia* for 1898 is occupied by the conclusion of C. Mueller's "Analecta bryographica Antillarum," and the first installment of Hennings's "Fungi Americani-boreales." Among the latter Hennings is still finding a good grist of new species.

Bolander, well known by name at least to all students of Californian botany, is the subject of a biographical sketch, with portrait, in *Erythea* for October.

In the *Proceedings of the Linnæan Society*, October, 1898, is given a half-tone figure of the special gold medal presented to Sir Joseph Hooker by the Society on the occasion of the completion of his *Flora of British India.* The obverse bears a relief bust of Dr. Hooker, modeled very faithfully by Bowcher, while the reverse is margined by a wreath of Sikkim rhododendrons, surrounding a suitable inscription.

The American Botanist is the name under which another journalistic effort is launched by Charles Russell Orcutt. While his previous papers have hailed from the Pacific coast, this, of which Vol. I, No. 1, appeared in September, seems to come from the Gray Herbarium of Harvard University, though a note by Dr. Robinson in the *Botanical Gazette* makes it appear that it is not to be regarded in any way as an official publication of the herbarium. The initial (and unique?) number is devoted to "an attempt at forming a record for the botanic garden of Harvard University, aiming to present the history and individuality of each specimen plant,"—a point in which Mr. Orcutt is believed to consider most American gardens very defective, — and deals with the cacti, not even excluding the glass models of the Ware Collection.

PALEONTOLOGY.

Habits of Thylacoleo. — In a recent number of the *Proceedings of the Linnæan Society of New South Wales*, Dr. R. Broom revives the question of the habits of a remarkable extinct Australian form, which led to a famous controversy between Sir Richard Owen and Sir William Flower. In 1859 Owen presented Thylacoleo as "one of the fellest and most destructive of predatory beasts, with affinities to the Dasyuridæ." Later, moreover, in 1866, he adhered to this interpretation of the large back cutting teeth, although in the mean time a pair of procumbent tusks had been discovered, which appar-

ently related this form to the herbivorous diprotodont marsupials. In 1868 Flower presented the entirely contradictory view, that Thylacoleo differed in every respect from the carnivorous marsupials, and was simply a harmless vegetable feeder, totally unfitted for preying upon the large contemporary marsupials. This called forth a violent reply from Owen in 1871. But subsequently Flower's position was supported by Krefft and Lyddeker, and is the one now generally received.

Dr. Broom's excuse for reviving this question is, that in general he has concluded to support Owen's opinion. He says there are insuperable difficulties in the way of considering Thylacoleo as a bulb or fruit eater. With its remarkable dentition such an animal would be unable to do more than slice its fruits and vegetables, even if it could have procured both in abundance. With succulent roots and bulbs the same difficulty arises as with the fruits; that even the most succulent, if we could suppose them digestible in slices, cannot be had in a succulent condition all the year round. When we look at Thylacoleo, he continues, we find not only the enormous temporal muscles and only moderate masseters, as in carnivorous animals, but that everything about the skull seems to be built on carnivorous lines. There is thus in his opinion no other conclusion tenable than that Thylacoleo was a purely carnivorous animal, and one which would be quite able to kill and probably did kill animals as large or larger than itself. He then proceeds to show in what manner Thylacoleo could have originated from small, shrew-like forms of Phalangers.

In the reviewer's opinion this revival of Owen's view is quite unjustifiable. It appears that the main argument of Dr. Broom is based upon the relations of the muscles of the jaw, and in reply it may be observed that all the early types of North American Herbivora of the Eocene period have enormous temporal fossæ and powerful sagittal crests *as an inheritance from their Unguiculate or clawed ancestors.* These temporal fossæ are so different from the rounded skulls of recent Herbivora, that one is very apt to be misled. The reviewer recalls very distinctly his discovery twenty years ago of the back portion of the skull of Palæosyops, an ancestral Titanothere, with its powerful zygomatic arches and large sagittal crest. These carnivorous structures led to the entirely mistaken belief that this peaceful herbivore was a new and exceptionally large carnivore. Dr. Broom's reasoning appears to be entirely similar and equally false.

H. F. O.

PETROGRAPHY.

Marble. — Vogt[1] has given an abstract of the geology of marble deposits, together with an account of the structure and mechanical properties of the rock. He defines marbles as metamorphosed limestones in which complete crystallization has occurred, and divides them into regionally metamorphosed marbles and those produced by contact action. The latter are characterized by the presence of garnets, vesuvianite, scapolite, wollastonite, etc., and the former by the presence more particularly of quartz, grammatite, actinolite, and other hornblendes. Nearly all the marbles of commerce are dynamically metamorphosed rocks. The difference in microscopic structure between the two classes of marbles is illustrated by several figures representing thin sections, and the difference between calcite and dolomite marbles is illustrated by several other figures. Grains of dolomite are shown to interlock by much less complicated contours than those of calcite. The reasons for their variations in structure are discussed at some little length. The article is a thorough one in every respect and is well worth study.

Grits Metamorphosed into Crystalline Schists. — Callaway[2] describes the transformation of a series of grits and shales into what he regards as true crystalline schists. The phenomena were observed near Amlwch, North Anglesey. Grits, which in their original form are clearly clastic, have been changed by dynamic agencies into chlorite schists. The quartz grains of the original rocks have been changed into areas of interlocking grains, and the matrix in which they were imbedded has been altered to a felt of chlorite, of mica, or a mixture of the two. In extreme cases the quartzes have been squeezed out into lenticules and bands of quartz mosaic, and between these have developed bands of chlorite and muscovite.

Dioritic Rocks of the Pusterthal. — Spechtenhauser[3] and Cathrein[4] give us very thorough accounts of the dioritic dikes and stocks at St. Lorenzen in the Pusterthal. The former describes the dike forms as diorite-porphyrites and norite-porphyrites. The diorite-porphyrites include quartz-mica-porphyrites, quartz-hornblende-por-

[1] *Zeits. f. prakt. Geol.* (1898), pp. 4 and 43.
[2] *Quart. Journ. Geol. Soc.*, vol. liv (1898), p. 374.
[3] *Zeits. d. deutsch. geol. Ges.*, vol. l (1898), p. 1.
[4] *Ibid.*, p. 257.

phyrites, and augite-diorite-porphyrites (kersantites). The norite-porphyrites are all quartzose. Besides these he gives a few notes on some granular stock-rocks that are intermediate in composition between quartz-diorites and quartz-norites.

Cathrein points out the fact that the porphyrites have a granular groundmass and in other respects are closely allied to granular diorites. Among these he mentions the existence of töllites, vintlites, and suldenites. The töllites differ from the tonalite-porphyrites in being more basic and in containing a very little quartz but a large quantity of garnet. The vintlites contain dihexhedra of quartz as phenocrysts in a fine-grained green matrix. The type is not that described by Rosenbusch in his "Physiographie." The author would include all the rocks above described and those of Klausen under the name "Klausenite." They vary in composition between biotite-hornblende-diorites and corresponding rocks in which orthorhombic and monoclinic pyroxenes and often some quartz occur. The variation in their structure appears to be due to their varying composition rather than to their mode of occurrence. From the fact that diorites, norites, and gabbros are often found to intergrade, he regards them as constituting a great family. The Klausenites are the quartziferous forms of these. The author concludes his discussion with an argument against the use of different names to designate the dike and effusive forms of the porphyrites. He would class them together as diorite, norite, and gabbro-porphyrites.

Three California Rocks. — A peculiar dike rock cutting the granodiorite on the ridge between Butte and Plumas Counties, California, consists of quartz, plagioclase, and needles of an amphibole in a granitic aggregate. The amphibole is in largest quantity. Turner[1] reports its composition as follows:

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	NiO	CaO	BaO	MgO	K_2O	Na_2O	$H_2O < 110°$	$H_2O > 110°$	Total
54.64	.61	12.09	1.81	5.03	.13	.05	7.74	.05	11.86	1.01	2.35	.12	2.44	= 100.01

A new amphibole-pyroxene rock is also described by the same author from Mariposa County, California, and a quartz-alunite rock from Indian Gulch in the same county. The former is made up of augite and amphibole grains, a little quartz, and some pyrrhotite, forming a matrix through which are scattered large phenocrysts of brown amphibole. The quartz-alunite rock is a metamorphosed clastic. An analysis of the alunite separated from it gave:

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	CaO	K_2O	Na_2O	H_2O at 100°+	SO_3	Total
2.64	.40	38.05	.23	.55	4.48	2.78	11.92	38.50	= 99.55

[1] *Amer. Journ. Sci.*, vol. v (1898), p. 421.

An Acid Pegmatite in a Basic Rock. -- An interesting occurrence of an acid pegmatite in a basic rock is described by Jaggar.[1] It exists as lenticular or vein-like masses that merge gradually into the diabase forming the Medford dike in the Boston basin. As the pegmatite, which is a quartz-microcline aggregate, is approached, the white plagioclases of the diabase acquire a salmon-colored zone of more acid material. The plagioclase finally disappears and microcline takes its place. At the same time quartz replaces all the bisilicates. In some places the pegmatite appears to have been infiltrated into miarolitic spaces. Quartz inclusions in the diabase are often surrounded by inner zones of micropegmatite and outer ones of augite. The latter are the usual reaction rims so frequently discovered around acid inclusions in basic magmas. Within these the liquids bearing the pegmatite-producing minerals deposited their burdens and at the same time corroded the quartz of the nucleus. The conclusion arrived at, to the effect that granophyric intergrowths of quartz and feldspar are not necessarily primary growths, seems to be well substantiated.

Notes. — Vogt[2] gives a *résumé* of the facts bearing on the theory of deposition of ore bodies by differentiation processes in eruptive magmas. He points out that in the same magma we often find oxidation products, sulphides and metals, all of which must be regarded as normal differentiation products of the rocks in which they occur. The facts of differentiation are well known, but of the cause of differentiation we are yet ignorant.

Three kersantite[3] dikes cut the kamm-granite north of the Leberthal near Markich in Elsass, and several sheets and dikes of quartz porphyry occur in the Robinatthal.

The crystalline rocks of southeastern New York, east of the Hudson, are granites, gneisses, mica-schists, serpentine and basic and acid intrusives. Merrill[4] reports the oldest of these rocks to be a hornblende granite. This forms the central mass of the Highlands. On its flanks are banded gneiss composed of orthoclase and quartz, biotite and hornblende and containing beds of magnetite; and associated with this is the well-known mica-schist of the district.

[1] *Amer. Geol.*, vol. xxi (1898), p. 203.

[2] *Compte-rendu du cong. géol. intern.* 6e Sér. (1894), p. 382.

[3] Bruhus, W. Mitth. d. geol. Landesanst. v. Elsass-Loth., vol. iv (1897), p. cxxix.

[4] Merrill, F. J. H. *New York State Museum Report* (1896), p. 21.

These rocks are intruded by redbiotite-granite, diorite, norite, serpentine and gray granite. The mica-schist is regarded as a metamorphosed sediment. Under the sediments, but above the archean granites and gneisses, is the gray banded Fordham gneiss composed of alternating quartzose and biotite bands and injected parallel to the banding by pegmatite or granite. This, it is thought, may be an Algonkian sediment. The Yonker's gneiss, which in an earlier article the writer concluded to be a metamorphosed sediment is now thought to be an intrusive. All the serpentines of the district are also believed to have been derived from igneous rocks.

SCIENTIFIC NEWS.

DR. W. R. OGILVY GRANT, of the British Museum, and Mr. H. O. Forbes, of the Liverpool Museum, have gone on a collecting trip to the Island of Sokotra.

The University of Indiana will locate its biological station this year at Warsaw, Ind. Applications for accommodations should be addressed to Professor C. H. Eigenmann, at Bloomington, Ind.

Tufts College opened a temporary zoological station last summer on the shores of Casco Bay. The authorities now have under consideration the establishment of a permanent station in that locality, which is remarkably rich in animal life.

The University of Kasan is sending out an expedition to Central Asia under the direction of Professor Sorolin. Geology, geography, and ethnology will be the most prominent subjects of investigation.

Dr. Charles F. Millspurgh, of the Field Museum of Chicago, goes on his fourth expedition to Yucatan, where he will continue his studies of the flora of that country.

Mr. D. G. Fairchild, of the United States Department of Agriculture, has started on a second long journey around the world, his first objective point being South America.

We regret to announce the death of Mr. Gilbert H. Hicks, botanist in charge of the seed control work of the United States Department of Agriculture. Mr. Hicks died on December 5, after a brief illness, aged 37. His official position was that of First Assistant in the Division of Botany. The *Asa Gray Bulletin* was also under his editorial charge. He leaves much unfinished scientific work.

The Munich Academy of Sciences has elected Professor Barrois, of Lille (geologist), and Professor Hartig, of Munich (botanist), to membership.

Professor George T. Allmann, well known for his investigations upon the Fresh-water Polyzoa and upon the Gymnoblastic Hydroids, died in November. He was born in Ireland in 1812, was appointed professor of natural history in the University of Dublin in 1844. In 1855 he was called to a similar chair in the University of Edinburgh,

where he remained until 1870, when he was succeeded by the late Prof. Wyville Thompson.

Cornell University will maintain summer schools during the coming summer in botany, entomology, geology, and zoology.

Dr. G. K. Niemann, professor of geography and ethnology in the Indian Institute in Delft, Holland, has resigned after twenty-five years of service.

Professor F. W. C. Areschoug, the well-known botanist, has resigned from his chair in the University of Lund, Sweden.

The Natural History Society of St. Petersburg has established a biological station on the shores of Lake Bologoy.

Recent appointments: Dr. R. T. Anderson, instructor in histology and embryology in Harvard Medical School. — V. H. Blackman, fellow in botany in St. John's College, Cambridge. — Dr. G. Bodi, assistant in the botanical institute at Innsbruck, Austria. — Dr. G. P. Eaton, assistant in osteology in the Peabody Museum of Yale College. — Dr. Marcus S. Farr, curator of the zoological collections in the state museum at Albany, N. Y. — Stanley Flower, of Bangkok, superintendent of the Cairo Zoological Gardens. — Dr. A. Y. Grevillius, of Münster, assistant in botany in the agricultural experiment station at Kempen on the Rhine. — Professor Hofer, of Munich, professor of geography in the University of Würzburg. — Mr. F. G. Hopkins, lecturer in chemical physiology in the University of Cambridge. — Dr. K. Keller, professor of zoology in the University of Zürich. — John Alden Loring, assistant director of the New York Zoological Gardens. — Mr. Horace Middleton, fellow in zoology and physiology in Magdalen College, Cambridge. — E. A. Minchin, lecturer on biology in Gray's Hospital Medical School, London. — Herbert Osborn, of Ames, Iowa, professor of zoology in the University of Ohio at Columbus. — Wladimir I. Palladin, professor of botany in the newly established technical school in Warsaw. — Alexander Hamilton Phillips, assistant professor of mineralogy in Princeton University. — Dr. Mark V. Slingerland, of Cornell, state entomologist of New York. — Dr. F. R. Stubbs, instructor in histology in Harvard Medical School. — Dr. C. O. Townsend, botanist and plant pathologist of Maryland. — Mr. Swale Vincent, Sharpey physiological scholar and chief assistant in the physiological laboratory of University College, London. — Dr. Frederick A. Woods, instructor in histology and embryology in Harvard Medical School.

Recent deaths: Prof. Rudolf Adamy, director of the ethnological museum at Darmstadt, aged 48. — Dr. James Edward Tierney Aitchison, author of numerous papers on the flora of India, in Kew, England, September 30, aged 63. — Dr. C. J. Backman, the Swedish botanist, May 1, in Stockholm. — James Behrens, formerly an active student of the Lepidoptera, at San José, Cal., March 6, aged 74. — Pasquale Conti, botanist in Lugano. — Sir George Gray, well known for his investigations of the resources of Australia and New Zealand, Sept. 19, 1898, aged 86. — G. E. Grimes, assistant on the geological survey of India, April 11, aged 26. — James Hardy, of Cockburnspath, England, a student of the zoology of northern England, October, aged 84. — Max Hauer, microscopist and mineralogist in Oberhausen, Germany, August 10, aged 51. — Dr. W. Kochs, privat docent for physiology in the University of Bonn. — Dr. Luigi Lombardini, professor of the anatomy of domesticated animals in the University of Pisa, June 27, aged 67. — Dr. Karl Mettenheimer, formerly a student of the invertebrates, in Schwerin, Germany, September 18, aged 74. — Johnson Pettit, entomologist, at Grimsby, Canada, Feb. 18, 1898. — Dr. Alexandre Pélliet, curator of the anatomical collections of the Musée Dupuytren in Paris. — Edward Tatnall, a student of the flora of Delaware, at Wilmington, May 30, aged 79. — Dr. Giambattista Valenzia, zoologist, at Pantelleria, June 15.

PUBLICATIONS RECEIVED.

(The regular exchanges of the *American Naturalist* are not included.)

ECKSTEIN, KARL. Repetitorium der Zoologie. Ein Leitfaden für Studirende. Leipzig, W. Engelmann, 1898. viii + 435 pp., 281 figures. 8 Marks. — HERTWIG, R. Summaries in Systematic Zoology. Translated and adapted by Albert A. Wright. Second edition. Oberlin, O., E. F. Goodrich, 1898. 35 pp. — PEABODY, J. E. Laboratory Exercises in Anatomy and Physiology. New York, Henry Holt, 1898. x + 79 pp., 8vo. — VERWORN, MAX. Beiträge zur Physiologie des Centralnervensystems. Erster Theil. Die sogenannte Hypnose der Thiere. Jena, Gustav Fischer, 1898. vi + 92 pp., 18 figures. 2.50 Marks.

BESSEY, E. A. Comparative Morphology of the Pistils of the Ranunculaceæ, Alismaceæ, and Rosaceæ. *Bot. Gazette*. Vol. xxvi, No. 5. — SHERWOOD, W. L. The Frogs and Toads Found in the Vicinity of New York City. *Proc. Linn. Soc. of N.Y.* 1897–1898, No. 10.

Bulletin of the Johns Hopkins Hospital. Vol. ix, No. 92. November. — *Geographical Journal.* Vol. xii, No. 6. December. — *Indiana Academy of Science.* Proceedings. 1897. — *Maryland Agricultural Experiment Station.* Bulletin No. 57. Report on the San José Scale in Maryland, by W. G. Johnston. — *Revista Chilena de Historia Natural.* Anno II, No. 9. September. — *Revista de Sciencias Naturaes e Sociaes.* Vol. v, No. 20. Porto, 1898. — *Royal Society of Victoria.* Vol. xi (N. S.), Pt. i. — *Sociedad Cientifica "Antonio Alzate"* (Mexico), *Memorias y Revista.* Tome xi, Nos. 9–12. 1897–1898. — *R. Università degli Studi di Siena, Bull. del Laboratorio ed Orto Botanico.* Anno I, Fasc. 2, 3. June.

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DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE

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THE

AMERICAN NATURALIST

VOL. XXXIII. *March, 1899.* No. 387.

THE PRESENT STATUS OF ANATOMY.[1]

J. PLAYFAIR McMURRICH.

It is a prevalent belief among the laity that anatomy is a practically completed study, that there is little or nothing to be added to our knowledge of the structure of the human body; and for such a belief there is a certain amount of excuse. The human body has been an object of anatomical study and investigation for centuries; hundreds of volumes, ranging from duodecimos to folios, have been written about its structure; thousands on thousands of bodies have been dissected; and why, then, are we not in possession of a full knowledge of the subject?

Such reasoning overlooks the fact that in every science there is not one but two elements, the material and the intellectual, which react upon one another, new observations producing new generalizations, and these again pointing the way to new fields for observation. But the misconception as to the present status of anatomy depends upon a misconception of a more fundamental idea, *i.e.*, of what is meant by science. To the popular mind science is merely the collecting of natural facts. The

[1] An address before the Catholepistemiad Club of the University of Michigan, Dec. 16, 1898.

scientist is pictured as an inquiring Gradgrind, who seeks for facts, facts, and nothing but facts; he weighs, he measures, and he describes; and weighing, measuring, and describing constitute science. No! The collection of facts, no matter how accurately accomplished, is no more science than the alphabet is literature. As Huxley has well put it, "the mere accumulation of facts without generalization and classification is as great an error intellectually as, hygienically, would be the attempt to strengthen by accumulating nourishment without due attention to the primal *viæ*, the result in each case being chiefly giddiness and confusion in the head." Observation alone is not science; facts without deduction are merely the clay without the straw. Observations, accurate and extensive, are a primal necessity, but observation alone merely furnishes the crude material from which, by reflection and deduction, scientific facts may be obtained.

So then, what is usually regarded as the whole of anatomy — descriptive anatomy — is not necessarily a science; it constitutes merely an aggregate of facts upon which deduction may act, and it is the sum-total of the observations and deductions that constitutes the science.

The purpose of this address is to consider chiefly the general standpoint of anatomy as it is at present, but a few words seem necessary concerning the more observational side. The facts or observations at the disposal of the anatomist of to-day are enormously more numerous and detailed than those available at, let us say, the beginning of the present century; and this progress along the material side has been largely due to the greater facilities for observation which we now possess. The anatomists of the sixteenth and early part of the seventeenth century possessed only such information as was afforded by the use of the scalpel and their unaided vision. In the seventeenth century a new tool was placed in their hands, the microscope, without which the anatomist of to-day is well-nigh helpless. At once new fields for observation were revealed and many new facts were secured, though for many years the microscope was rather a plaything than a tool. Indeed, it was not until the present century was well advanced that the optical imper-

fections of the compound microscope were overcome and the instrument we now so constantly employ was within reach.

But, after all, the microscope, *per se*, in anatomy has enormous limitations. A fragment of tissue taken from the body and placed at once beneath the strongest powers of the microscope yields but few of its secrets. The great development in the modern use of the microscope, if I may so express myself, has been in the methods of preparation of the tissues to be examined, methods which have become so familiar to workers with the microscope that they are apt to forget how very recent they are. The hardening of tissues was not introduced until the beginning of the present century (Reil), and then alcohol alone was used; the processes of "fixation" previous to hardening had their origin in the discovery of the value of osmic acid for this purpose by Max Schultze in 1864; section cutting, even free-hand, was not generally employed until after the middle of the present century; staining was first employed by Gerlach in 1858; and mounting in refractive media was introduced by Stilling about the same time as section cutting (1840).

How rapid, then, has been the development of our modern methods! To-day instead of one "fixative" we have our choice of many; instead of cutting our sections with the free-hand and spoiling many, we have instruments of precision by which we can cut an entire organism or a piece of tissue into sections $\frac{1}{2500}$ of an inch in thickness without spoiling one, and, if necessary, can obtain sections of $\frac{1}{10000}$ or even $\frac{1}{25000}$ of an inch, so perfect have our methods become. While Gerlach knew only one medium for staining, namely, carmine, to-day we have dozens, the discovery of the anilines placing in our hands a marvelous aid to microscopical investigation. By their use we can differentiate tissues. One dye will have an affinity for nerve tissue, another for yellow elastic tissue, another for mucin; others will affect most strongly the chromatin of the cell nucleus, others the cell body or cytoplasm, and so on; and thus, by choosing the proper method, it is possible to differentiate structures in a most marvelous manner.

So then the anatomist of to-day, by the proper employment of the methods at his disposal, has it in his power to make

observations undreamt of, in their minuteness, by the masters of fifty years ago, and wonderfully more perfect than those possible even fifteen years ago. How then, even from the observational side, can anatomy be a completed science?

But now, leaving this side of the story, let us examine the difference between the higher intellectual side of anatomy as it is to-day and what it was in the past.

It is interesting to note the impartiality of the intellectual stagnation of the Middle Ages. The neglect of Aristotle, so marked in philosophy, is paralleled by a similar neglect in the department of Natural History; Pliny, with his fabulous tales and uncritical compilations, being the great authority. In anatomy the condition was largely the same. Original observation was almost neglected, utmost reliance being placed upon the *dicta* of Galen and any attempt to criticise his statements regarded as a heresy. When, accordingly, Vesalius, in the first half of the sixteenth century, disregarding the dictates of antiquity and entering upon a course of investigation for himself, pointed out that the facts which Galen set forth as applicable to the human body, and which were in reality founded largely upon observations made chiefly in dogs and monkeys, were in many particulars erroneous, he encountered a storm of derision and obloquy. The correctness of his observations had to be recognized however, though with great unwillingness; but even then his opponents, notably his former teacher, Sylvius, maintained the correctness of Galen's descriptions and endeavored to explain away discrepancies by asserting that the structure of the human body must have changed since Galen's time. Vesalius had pointed out that the bones of the leg are not curved, as Galen had asserted. "Granted," cried his opponents, "but they were curved in Galen's time, and their straightness now is due to the substitution of close-fitting garments for the flowing robes of earlier times."

On the death of Vesalius in 1564, the influence of his opponents produced a revival of Galenism, but the leaven had begun to work and the zeal of Vesalius had marked an epoch in anatomy. Careful observation and description became more and more the order of the day, and led in 1619 to the dis-

covery by Harvey of the circulation of the blood, a discovery which marked a second great epoch in the history of anatomy. It laid the axe at the root of the spiritual theories prevalent at the time, which recognized as the essence of life an unknown something, the *spiritus* or *aura*, which, being confected in the liver, served to distend the heart, whence it was distributed as a *spiritus naturalis* by the veins to certain organs of the body, and as a *spiritus vitalis* to others by the arteries. Harvey's discovery necessarily proved a serious blow to such vague ideas, though in one form or another they continued to exist for nearly two centuries, the *spiritus* being a ghost difficult to lay. Harvey showed that the heart was not passive, but was a muscular pump, that the heart and not the liver was the starting point of the circulation, that the blood of the arteries and of the veins was the same, and that the course of the blood in both sets of vessels was in a definite direction. And by so showing he laid the foundation stone of our modern science of physiology.

But the seventeenth century is entitled to the credit of laying the foundation stone not only of physiology, but also of microscopical anatomy and of comparative anatomy. Leeuwenhoek, polishing his own lenses and subjecting to their action whatever came to his hand, made many important discoveries, chief among which appear bacteria, the yeast plant, and spermatozoa; and Malpighi discovered the blood corpuscles and completed the missing link in Harvey's scheme of the circulation by describing the capillaries by which the veins and arteries are placed in communication.

The interest awakened in human anatomy in the sixteenth century was not accompanied by an equal interest in the study of the lower forms, but towards the close of the seventeenth century comparative anatomy was again called to the aid of human anatomy by Nehemiah Grew, by Tyson, who availed himself of an opportunity for dissecting an ourang and carefully compared its structure with that of man, and by Collins, who with Tyson's aid illustrated the structure of the human body by references to the peculiarities of structure found in the lower animals.

And, finally, as a crowning glory of the seventeenth century, we must not forget the inauguration in it of the science of embryology, with which the name of Harvey must also be associated, his predecessor in the study being his teacher, Fabricius ab Aquapendente.

But it is merely the beginnings of these various adjuncts to anatomy that we find at this period. At this time, and indeed until much later, anatomy was regarded simply as a medical study, and investigation in it was conducted for a distinctly practical end. On account of its relations to medicine it came under the influence of the medical theories which prevailed at the time, and these theories, frequently changing, at one time stimulated observation and at another retarded it. Anatomy, instead of flourishing under a theory of its own, was overshadowed by, or received but reflected lustre from medical theories, and it is of interest on this account to consider these latter briefly.

If I were asked to characterize in a few words these theories, I would say that they belong to two distinct classes, those of the one class being based upon a dualistic conception of the structure of the body, while those of the other might be termed monistic. Those of the one class seem to have served as stimuli to those of the other, and the history of the theory of medicine from the sixteenth to the beginning of the nineteenth century has been a history of an almost regular alternation of dualistic and monistic hypotheses. As pertaining to the dualistic group, the sixteenth century doctrines of Paracelsus may be mentioned, according to which the physiological and pathological processes of the body were the result of a controlling spirit, termed the *Archeus*, and this view was also maintained with slight modifications by Van Helmont in the beginning of the seventeenth century, he, too, recognizing a dominant Archeus to whom were subordinate other *Archei insiti*, disease being due to "the passions and perturbations of the Archeus," and the treatment of the physician an attempt to modify the ideas or emotions of this *ens*.

Naturally there was ere long a reaction from such a fantastic hypothesis, and we find in the seventeenth century two monistic

schools, the Iatro-chemical and the Iatro-physical, which, as their names indicate, regarded the physiological processes of the body as chemical or physical in their nature. These theories were, however, too advanced for the times, and even Sylvius, the chief exponent of the chemical school, while regarding many diseases as the result of disturbances of the chemical processes of the body, still held to the idea of a *spiritus* when it was a question of nervous disturbances.

Later, at the beginning of the eighteenth century, Boerhaave emphasized the monistic views, and to a certain extent combined the principles of the two schools just mentioned by finding the causes of disease in the degree of cohesion of the particles composing the elementary fibres of the body and determining their strength or feebleness, their laxity or tenseness, and in the chemical and physical characters of the body fluids, their acidity, alkalinity, or viscosity. And almost at the same time we find a revival of the dualistic idea in the animism of Stahl, who revived to a certain extent the Archeus of Paracelsus under the name of the "anima" as the controlling element of the physiological processes of the body.

But it would take too long to even merely touch upon the numerous theories which marked the eighteenth century as the age of systems. The desire then prevalent of establishing a general principle which would govern the practice of medicine seems to stand in close relation to the tendency to establish systems which became evident in the philosophy of the times, and, if time permitted, it would be interesting to consider the influence of such minds as Descartes and Leibnitz on the medical theories of their day.

To a certain extent these various and vacillating theories retarded the progress of anatomy and physiology, but not entirely so. For a theory is merely a working hypothesis, an index of the lines along which further observation should proceed, and so, even though it may be fundamentally erroneous, it need not necessarily obscure for long the progress of thought, the observation which it stimulates soon correcting it and substituting for it more accurate ideas. The search for the elixir

of life yielded many valuable results to chemistry; for, as Cowley has expressed it:

> So though the Chymist his great secret miss
> (For neither it in art or nature is);
> Yet things well worth his toil he gains,
> And does his charge and labour pay
> With good unsought experiments by the way.

And so, though under the influence of erroneous theories and in an attempt to elucidate by commentaries the physiological ideas of Boerhaave, Haller, between 1746 and 1765, added greatly to the knowledge of anatomy and placed another stone on the foundation of modern physiology by the discovery of the contractility of muscle and the irritability of nerve.

The close of the century, or, rather, the beginning of the nineteenth, was marked by the appearance of a work of far different calibre than the majority. I mean the *Anatomie générale* of Bichat, published in Paris in 1801. Bichat combines, to a certain extent, the monistic tendencies of Boerhaave with the animistic ideas of Stahl, but, making use of Haller's discovery and by adding much of his own, he evolves a much more scientific and progressive system. He recognizes Stahl's animism as a pure abstraction and supplants it with two physiological processes, the irritability and contractility of Haller, which, he claims, are properties of all organs of the body and not of nerve and muscle alone. Digestion, circulation, secretion, in fact all the functions, are performed by the interaction of these two processes. So far this is an improvement in Stahl's ideas, but the great importance of Bichat's theories rests in that he makes these vital processes reside in the solids of the body. They are not absolute entities controlling the functions of the body, but in a sense they are these functions, and since disease is a disturbance of the functions, a modification of the vital processes, it is dependent upon a modification of the solids or tissues of the body.

Such a theory necessarily led to a more minute and careful study of the finer anatomy of the organs of the body, both in health and disease, and indeed was the result of such studies carried out largely by Bichat himself. That the body was com-

posed of numerous organs was clearly understood, but Bichat pointed out that the structure and function of an organ is dependent upon components, the tissues, which enter into its formation. To quote his own words: "Every animal is an assemblage of different organs, which, each performing a single function, subserve, each in its own way, the preservation of all. They are so many special structures in the general structure which constitutes the individual. Now these special structures are themselves formed of several tissues of very different natures, and which, indeed, form the elements of these organs. Chemistry has its simple bodies, which form, by the various combinations of which they are capable, compound bodies; such simple bodies are heat, light, hydrogen, oxygen, carbon, nitrogen, phosphorus, etc. Similarly, anatomy has its simple tissues, which, by their combinations in fours, sixes, eights, etc., form the organs." Elements of lower grade than the organs had been postulated in earlier times; thus Boerhaave speaks of elementary fibres which form certain structures and Asclepiades, still earlier, applied to anatomy the Epicurean doctrine of atoms. But one of these was a philosophical abstraction and not a scientific hypothesis, and the other a crude generalization not applicable to all parts of the body. Bichat's tissue element is, however, accepted to-day as an individual of simpler grade than the organ individual, and though we do not recognize as perfect his definition of tissues or his enumeration of them, yet the ground idea is the same, except in so far as it is influenced by the cell theory of a later date.

If, now, the epoch-making discoveries in the history of anatomy in the sixteenth, seventeenth, and eighteenth centuries were to be summed up briefly, there would be placed first and foremost the overthrow of the Galenian traditions, and the revival of observation by Vesalius (1516–34); next the discovery of the circulation of the blood by Harvey (1619); next Haller's discovery of the irritability and contractility of nerve and muscle (1746), and, finally, the formulation by Bichat of his tissue elements and the overthrow of both the ultra-physical and the ultra-animistic theories of disease (1801).

During all the period hitherto considered anatomy remained

very largely in the observational stage, and was ancillary to medicine. In the mean time, however, investigations were proceeding in allied branches of biological science, which were destined eventually to place anatomy in the category of the sciences.

In Germany, Johannes Müller and Meckel; in England, Hunter, Home and, later, Owen; and in France, Vicq d'Azyr, Étienne, and Isidore Geoffroi St. Hilaire, Lamarck and, especially, Cuvier, prosecuted with vigor and enthusiasm the study of comparative anatomy, the results of their observations calling into existence two diametrically opposed deductions, on the one hand the doctrine of Types espoused by Cuvier, and on the other that of Transformationism, upheld by Étienne Geoffroi St. Hilaire and Lamarck. Cuvier's theory, briefly stated, was that in the animal world there was a definite number of structural types or plans, to one or other of which every animal could be referred. The theological bias of the theory was strong; the plans or types, having existed in the mind of the Creator from the beginning, were fixed and immutable; connecting links between them were impossible; they were circles whose boundaries might touch but could never overlap. And, furthermore, the theory involved the idea of a special creation for each species, the species being consequently as immutable as the types. Man, therefore, was structurally isolated, and the similarities known to exist between him and lower forms could have no significance.

To Lamarck and St. Hilaire the facts of comparative anatomy pointed to entirely different conclusions. To them there was a fundamental unity in the animal kingdom; as some one has said, they took a synthetic, and Cuvier an analytic, view of nature. This unity was possible only by an absence of a fixity of type, by a mutability of species, and these were the ideas they opposed to Cuvier's scheme of creation, the ideas of transformationism or evolution practically as we now understand it.

The controversy between the two schools was prolonged and bitter, and culminated in the celebrated passage of arms before the Academy of Sciences in Paris, which, to Goethe, seemed more important than the victories of Napoleon. The enormous

authority of Cuvier and the theological bias of his theory gained the day, however; the doctrine of transformationism retired temporarily from the field, and anatomy retained its isolated position.

Attention has already been called to the inauguration of the science of embryology by Fabricius and his pupil Harvey. During succeeding years it languished somewhat, but was finally established as an important branch of biology in the present century by the publication of the *Beobachtungen und Reflexionen* of von Baer in 1829. A masterly study of the development of a number of vertebrate organisms led von Baer to formulate a principle of developmental unity by his doctrine of the germ layers, and also to establish an idea of transformationism for the individual by demonstrating that in its development the organism proceeds from a more generalized to a more specialized condition; that is to say, it presents first what for convenience may be termed type characteristics, later the family, then the generic, and then the specific peculiarities being added or superimposed.

About the same time important ideas were working out in another department — that established by Malpighi and Leeuwenhoek — microscopical anatomy. Improvement of the microscope made possible the discovery in 1838 by the botanist Schleiden of cells as the ultimate structural units of plants — a discovery completed in the following year by Schwann, who extended the generalization to animals, and at the same time materially modified the meaning attached to the word *cell.* These discoveries were the following out of the idea of analysis suggested by Bichat, and were indeed the analysis of his tissue elements into individuals of a still lower grade. A further step was, however, still necessary to convert the cell-theory of structure into its modern form, and that was the formulation of the protoplasmic theory by Max Schulze in 1861. Just as cells had been known long before the cell theory was postulated, so, too, protoplasm had been known ever since the amœba was first observed by Rösel von Rosenhof in 1755. The attention to the nature of the cell contents, awakened by the cell theory, led the botanist von Mohl to recognize in vegetable cells a viscous

material distinct from the cell sap, to which he gave the name protoplasm. This was in 1846, but even before this Dujardin, in 1835, had described what he termed the *sarcode* in the Foraminifera. Schulze much later identified these two substances and modified the original cell theory by making a mass of protoplasm, independent of any special bounding wall, such as the word *cell* implies, the unit of structure. He converted Bichat's tissue elements into aggregates of protoplasmic elements, and, by extending his generalization to plants, made possible Huxley's characterization of protoplasm as the "physical basis of life."

All these discoveries and hypotheses were contributing to prepare the mind of the scientific world for the reawakening of the doctrine of evolution. The theological bias and the influence of Cuvier were still powerful at the middle of the century, but they could not withstand the march of observation and deduction which was tending surely to the overthrow of the Type theory, a result accomplished by the publication of Darwin's *Origin of Species* in 1859. Darwin's generalizations and the resulting acceptance of the theory of evolution at once placed anatomy in a new position. It could no longer be held aloof from the other biological sciences. Man is not an organism entirely distinct from all others; he is merely the culmination of one line of evolution. His structural peculiarities are not minute details of a primary immutable plan, but are to be explained by reference to his past history. Departures from the typical conditions, so frequent and in many cases so remarkable, are not mere vagaries without significance, but are reminiscences of previous conditions or indications of developmental possibilities frequently brought to completion in other forms.

The doctrine of evolution is the "one increasing purpose" whose influence is traceable throughout all science, and it has consequently broadened all our views by bringing the various departments of research into interdependence with one another. This is the age of specialties, and necessarily so, since the volume of knowledge has grown too great for one finite mind to comprehend the whole; but now, more than ever before, there is necessity for correlation. Each department of science

no longer stands isolated; no longer can a thorough and extensive research in any specialty be conducted without reference to other specialties and other departments. And it is this which stands out so clearly in the science of anatomy as it is to-day. It is no longer an isolated study, but merely a part of a wider field of knowledge. In the past it was a land-locked sea, but the erosion of the smaller streams of discovery and, finally, the overwhelming flood of the evolution hypothesis swept away the barrier which separated it, and it is now a small bay of the great ocean of morphology. In the past anatomy was human anatomy ; to-day it is synonymous with morphology. No longer do anatomists confine their attention to merely accurate descriptions of the details of the structure of the body; they seek to discover the significance of these details. Anatomy has become "denkende Anatomie," to use the expression of Johannes Müller; it is no longer tied to the apron-strings of its mother, Medicine, but, having come of age, has taken its place in the rank of the sciences, the *Origin of Species* and the *Descent of Man* having been its Declaration of Independence.

How, then, can our knowledge of the structure of the human body be complete? Modern anatomy is not yet fifty years of age, and this is infancy compared with the sister sciences. All that has been accomplished from the time of Aristotle to the middle of the present century was largely merely a preparation, and the time that has elapsed since then has been far too short for the solution of all the problems which confront us. Goethe has said of another department of study: "History must from time to time be rewritten, not because many new facts have been discovered, but because new aspects come into view, because the participant in the progress of an age is led to standpoints from which the past can be regarded and judged in a novel manner." So it is with anatomy; the new standpoint calls for a new interpretation of anatomical facts and a restatement of our knowledge of anatomy.

It seems unnecessary to run the risk of tediousness by enumerating the problems of anatomy of to-day, their number being endless. I trust I have made its present standpoint clear, so clear that he who will may read between the lines and

see that an anatomist can do as much, indeed I would even say he can do more for the advancement of his science by prosecuting investigations in comparative anatomy and embryology than by confining his attention to man alone. Why should the anatomist, endeavoring to unravel the mystery of the structure of the most complicated organism known to him, waste his time and energy in studying that organism alone, when he can trace step by step the gradual increase of the complexity in the lower forms of life, and, by learning to understand the simpler conditions, place himself in a position to understand the final complexity?

More than one hundred years ago the Abbé Dicquemare wrote: "Everything that relates to animals, their manner of being, the growth and diminutions which they show, their generation, their strength, their actions, their diseases, their nourishment, the duration of their lives, the phenomena which they manifest even in death, all these are subjects which ought to interest man. If his moral being does not offer any analogy to theirs, his physical constitution permits comparisons." The new anatomy is interested in all these subjects; it is catholic in its extent. From amœba to man every organism falls within the jurisdiction of the anatomist, and there is no problem of morphology but is his for solution, no observation however insignificant but is his for application. "Neque enim ad agendum et potestatem sive operationem humanam amplificandam sufficit, aut magnopere attinet, nosse ex quibus res constent, si modus et vias mutationum et transformationum ignores." These words of Lord Bacon would well serve as a motto for the anatomy of to-day.

PSEUDOMONAS CAMPESTRIS.

Behavior in gelatin containing varying amounts of Sodium hydrate. (See Gelatin Culture Media, — 2d Ann. Meeting Soc. for Plant Morphology and Physiology.)

THE SECOND ANNUAL MEETING OF THE SOCIETY FOR PLANT MORPHOLOGY AND PHYSIOLOGY.

ERWIN F. SMITH.

The second annual meeting of this society was held in New York, December 27–29, in affiliation with the American Society of Naturalists. All of the meetings were held at Schermerhorn Hall, in the new and very commodious quarters of the Department of Botany of Columbia University. The Torrey Botanical Club gave a reception to the society and visiting botanists on Tuesday evening, and throughout the meetings the New York botanists did everything that was possible to make the occasion pleasant and profitable. Five papers listed on the programme were not read owing to the absence of the authors, some of whom were detained by sickness. There were, however, more than enough papers to fill the allotted time, and the second meeting of the society closed as successfully as the first one. Professor Macfarlane was elected president for the ensuing year. The following additions were made to the membership of the society: Newcombe, Pollock, Underwood, Waite, Stewart, Halsted, Johnson. In addition to the papers abstracted below, Dr. W. G. Farlow, as retiring president, gave a very interesting address on Peculiarities of the Distribution of Marine Algæ in North America, and the secretary of the society, Dr. W. F. Ganong, gave a ten-minute address before the whole body of naturalists on Advance in Methods of Teaching Botany. Dr. Ganong's address was printed in *Science*, January 20. It is to be hoped that the president's address may be printed in full. Two of the statements in it which impressed the writer most were: (1) the gaps which still exist in our knowledge of the marine algæ, especially in Floridian and Pacific waters, and (2) the algal desert which extends along our eastern coast from New Jersey to South Carolina. The state-

ments given in the abstracts were, for the most part, furnished by the authors of the papers, the writer having simply put the abstracts into a condensed and coördinate form, with here and there an addition from his own notes.

PROF. JOHN W. HARSHBERGER: *Some Morphological Structures in Paulownia imperialis.* — *Paulownia imperialis* is a Japanese tree of umbrageous habit which thrives well and suckers freely in the neighborhood of Philadelphia and farther south. Its method of branching is sympodial. The main shoot, or leader, is terminated by an inflorescence. After the fruit is formed, and the seeds are discharged, the axis of inflorescence dies back to the point where the lateral bud is given off which develops into the leader of the next season. Beneath this shoot two other branches are also formed, which in succeeding years branch in the same way as the leading shoot.

This tree flourishes in Japan in valleys and on the sides of hills exposed to the powerful action of the sun. A study of the leaf structure shows that the plant has adapted itself to that kind of environment, branched, antler-like, interlocking, protective hairs occurring on the lower foliar surface.

The flowers are arranged in clusters of cymes, which approach the scorpioid type. The flower buds are protected by five thick sepals, which are covered with ferruginous protective hairs. The flower parts inside of the young buds are all well formed. The pollen is fully formed, as likewise the pistil. In the mature pod, which splits to discharge the seeds in December, there is found a fleshy placental disk rich in tannin, which may be either a reserve product or a waste substance.

In the petioles of the foliage and sprout leaves a number of different shaped crystals are found. These are all calcium oxalate, the difference in form being due to the different metabolic influences existing at the time of their formation. Peculiar refractive granules, the nature of which is not fully determined, are also found in the mesophyll cells of the leaves.

DR. W. F. GANONG: *On the Life History of Leuchtenbergia principis.* — This paper gave a synopsis of the author's studies upon the ontogeny of this rare and highly specialized species, the most noteworthy of the Cactaceæ. The paper traces the history of knowledge of the species, its systematic position, anatomy, morphology, etc. Its geographical distribution, habits and ecology, morphological composition as determined by comparative anatomy and ontogeny, and the

internal anatomy and its development are treated in full. This is intended by the author as the first of a series of life histories of important species of this family which are expected to yield data for a better understanding of principles of morphological modification under the influence of changing ecological factors.

This plant, which lives under arid conditions, represents the extreme of specialization along the Echinocactus line, as is clearly indicated by its embryology. It has a highly differentiated anatomy, the tracheid system being better developed than in any other plant known to the author. The mamillæ show three concentric rings of vascular bundles, a cortical ring, a ring leading to the spine system, and a central ring going to the flowers.

PROF. BYRON D. HALSTED: *Root Tubercules upon Spring and Autumn Grown Legumes.* — The ninth successive crop of wax beans upon the same plot (one-twentieth acre) grown in the spring of 1898 consisted of plants, the roots of which bore numerous large, nearly spherical tubercles. The plants of the succeeding crop grown in the summer upon the same soil had very few of the root galls.

The cause of this remarkable difference in the behavior of the same variety of leguminous plant in the same germ-laden soil must be ascribed to changes in soil conditions. During the early growth of the spring plants the soil was considerably cooler than in August, when the second crop was passing through the initial stages of development. There was, doubtless, aside from the different temperature of the soil, a wide difference in the amount of available soil nitrogen, it being much less in the comparatively cool earth of May than in the warmer ground of August.

The nitrifying germs of the soil, being more active in midsummer, provided a daily supply of combined nitrogen for the young growing plants. On the other hand, the spring crop, not having this ample supply was "nitrogen-hungry," and this furnished the proper condition upon the part of the host plant for the abundant development of the tubercles.

Successful inoculation of the plants with soil-extract or the pure culture of the tubercle germ "Nitragin" is dependent largely upon soil conditions, and many widely varying results may here find an explanation.

FRANCIS E. LLOYD: *Further Notes on the Comparative Embryology of the Rubiaceæ.* — The genera studied include Houstonia, Rubia, Sherardia, Vaillantia, Crucianella, Galium, and Asperula.

The Nucellus arises as a papilla, at the apex of which develop, in the hypoderm, about eight or ten macrospores which elongate, and many of which commonly germinate, reaching a quadri-nucleate condition. One (sometimes two) becomes the perfected embryo-sac, which in all forms studied has antipodals, a hitherto unrecognized fact (excepting in Houstonia). One of the antipodals is very large, comprising the whole lower half of the embryo-sac (Sherardia, Rubia, Galium). The condition in Asperula is not completely cleared up, but the material studied indicates that a larger number of antipodals are present, approaching in this respect certain Compositæ.

The pro-embryo has a suspensor which is divided into two regions, the micropylar and the embryonal. The latter is composed of disk-shaped cells; the former of large cells which are swollen out laterally, forming absorbing organs which become applied to the endosperm. A free preparation of these structures resembles a bunch of grapes, a condition similar to that described for Sutherlandia by Hofmeister and Guignard.

The integument becomes absorbed by the endosperm till only the outer layer of cells is left. The seed covering then consists of the pericarp and a single layer of cells derived from the integument.

Charles H. Shaw: *The Inflorescences and Flowers of Polygala polygama.* — In this plant the author has discovered a third set of inflorescences, namely, *green cleistogamic flowers, produced in late summer on geotropic aerial shoots.*

In the conspicuous pink-purple blossoms the style terminates in a dense hairy tuft, bearing the stigma as a lateral knob. The embryo sac is generally imperfect and the seed abortive.

In the underground cleistogamic flowers the wing-like sepals are reduced to the size of the other three, the two lateral petals are wanting, the stamens have decreased to six, five, four, three, or two, and the style and hairy tuft are reduced to the vanishing point, leaving the stigma closely sessile. On the other hand, they are more highly developed in at least two points, namely, the walls of the microspores are *exceedingly thick*, and the ovary is densely covered with *glandular hairs*.

The newly discovered aerial cleistogamic flowers furnish transition stages between these two sharply marked types. The style is better developed, and there are rudiments of the lateral petals. In the thickness of the microspore walls and in the structure of the pistil especially interesting connecting stages are found.

The cleistogamic flowers of both sorts produce more seeds than the conspicuous ones.

R. E. B. McKenney: *Observations on some Monocotyledonous Embryo-sacs.* — The development of two species of Scilla, *S. hyacinthoides* and *S. campanulata*, was described and reference made to the development of other Monocotyledonous Embryo-sacs. The archesporial cell is formed from a sub-epidermal cell. This cell grows rapidly and a small cell is cut off by a periclinal wall — the primary tapetal cell. The primary tapetal cell divides later by a periclinal wall, thus giving rise to an inner and an outer tapetal cell. The archesporial cell continues to grow and divides twice, giving rise to three cells. The upper one of these cells remains uni-nucleate, the lower becomes tetra-nucleate, and the middle one develops into the embryo-sac with its eight nuclei. It seems probable that each of the eight nuclei of the embryo-sac, as well as the four in the cell below, represents a macrospore. Hence, the embryo-sac may be considered as two sporocytes which never develop the separating wall. On this hypothesis, the cell above the embryo-sac and also the one below, each represents a sporocyte. Two cases in which such a partition in the embryo-sac has been observed were mentioned, one by Mann in Myosurus, and one by the writer in *Lilium candidum*. Especial attention was called to the extra-nuclear origin of the spindle fibres and to the entire absence of centrosomes. The author has slides made from *Lilium tigrinum* and *L. candidum*, which exactly confirm Mottier's statements as to the origin of the spindle in Lilium.

R. E. B. McKenney: *The Structure and Function of Crystal Cells in Sensitive Plants.* — The crystal cells in sensitive plants form a complete sheath around the bundle cylinder in stems and a half sheath around the bast of the leaf bundles. Each cell contains a single large crystal. These crystals usually have the shape of a hexagonal prism. Each one is imbedded in apparently homogeneous cytoplasm. The nucleus is very small and homogeneous, but a nucleolus is wanting. Sap vacuoles and starch are also absent. From tests made with hydrochloric acid, nitric acid, caustic potash, fluoric acid, etc., it seems probable that these crystals are very insoluble silicates. They are found in the ash after burning the plants. These silicate crystals are entirely wanting in the cotyledons and only make their appearance in the first leaf after it has been expanded for a day or two. The crystals are first found in the cells of the sheath at the

distal ends of the main bundles of the leaf as small spicular bodies. These gradually grow and assume the adult shape, but as they grow the nucleus becomes gradually smaller until it reaches its minimum size. Beginning with the cells at the distal end of the bundles, the crystals are developed in basipital fashion along the entire course of the bundle. The same course of development takes place in the bud leaves of old plants, only the crystals are fully formed before the leaf expands. These crystals were observed in several species of Mimosa, Acacia, and Oxalis. From the researches of Dutrochet and others it *seemed* as though the phloem was the region for the transmission of stimuli. However, since the crystal cells are closely applied against the phloem, and since they are best developed in the most sensitive plants and most poorly in least sensitive plants, it seems more probable that these cells constitute the *main* lines of transmission of stimuli. This tissue leads straight down to the pulvinus, but there are no crystals in the latter.

Amelia C. Smith: *Structure and Parasitism of Aphyllon uniflorum.* — The most conspicuous features of this plant are its parasitism on *Aster corymbosus* and the degradation attendant upon its parasitic habit as expressed by: (1) Absence of chlorophyll; degeneration of true leaves; loss of root hairs, and probably of root cap; reduction and degeneration of the bundle system, and relatively greater development of the phloem than of the xylem; small size of seed, and primitive embryo developed within a mass of tissue which is probably precocious endosperm. (2) Infrequence of stomata. Where present they are on the more exposed places, *i.e.*, outer surface of upper bract-leaves, upper part of flower stalks, and outer surface of calyx and corolla. (3) Abundance of starch. Starch is present in great quantities in root, stems, leaves, and carpellary tissue.

Sieve tubes seem to be entirely absent from the stem. The embryo is simply a mass of undifferentiated cells, *i.e.*, it is not distinguishable into cotyledons, plumule, and radicle. The use of the starch is problematic. The quantity stored in the endosperm is infinitesimal compared with that stored in other parts of the plant.

Dr. M. A. Howe: *On the Occurrence of Tubers in the Hepaticæ.* — The existence in this group of plants of tubers serving for vegetation propagation seems to have been, until very recently, almost unknown to plant morphologists. There are, however, four or five species, mostly of the genus Anthoceros, in which the occurrence of

tubers has long been known to systematists. This number has been recently increased until, at the present time, at least eleven species are known in which tuber-like growths occur. Of these, four belong to the genus Anthoceros, three to Riccia, two to Petalophyllum, one to Fossombronia, and one to Geothallus. It is to be expected that as the hepatic flora of the drier regions of the earth comes under more extended and accurate investigation, this evident adaptation for carrying the plant over a season of drought will be found to be much more common than has been generally supposed.

In the Californian *Anthoceros phymatodes* the tuber appears as a swelling near the apparent apex of the more or less well-defined costa of a Thallus-segment, becoming soon strictly ventral through the continued onward growth of the segment, and coming at the same time to be pendant from the ventral surface through the formation of a fleshy or slender and elongated peduncle. Tubers are globose or ellipsoidal in form, 0.25 to 1 mm. in diameter, at first smooth, but becoming at length thickly covered with root hairs. A cross-section of the body of the tuber shows it to consist of a cortex of 2 to 4 layers of nearly empty cells enclosing a central mass of smaller cells so densely filled with oil drops or with merely colorless granules that the cell boundaries in a section are rendered obscure. There is very little if any starch. In two cases, old tubers of *Anthoceros phymatodes* were found sending out new shoots, demonstrating that they play a part in the vegetative propagation of the plant. What had simply been inferred in regard to the function of these organs in the three tuber-bearing species of *Anthoceros* previously known has now been observed in this Californian species.

Dr. Henry Kraemer: *Morphology of the Genus Viola.* — About 30 species of violets, chiefly from the United States, have been examined with special reference to style and stigma, stamen spur, size and shape of the pollen grains, hairs upon the stamens and petals, presence of bracts, mucilage cells, etc. The paper, which represents a large amount of painstaking work, was illustrated by many drawings, photographs, and photomicrographs.

Bracts with characteristic mucilage-secreting hairs occur in all of the species, and sub-epidermal mucilage cells are present in the leaf, stem, and all parts of the flower except the stamens.

A number of species agree in having a nearly globular stigma with a more or less well developed lip-like appendage, a style with a geniculate bend in the lower part, and corkscrew-shaped hairs on the

spurred petal. This group includes *Viola heterophylla*, *V. lutea*, *V. tricolor*, and varieties. In the remaining species the stigma is straight or somewhat globular and is destitute of any lip-like appendage, the style is bent or straight, and if any hairs are present upon the petals, they are straight. This group may be further subdivided on the length of the nectar-secreting stamenspur as follows:

(1) Spur shorter than the anther cells. — *V. blanda*, *V. primulæfolia*, *V. lanceolata*, *V. palustris*, *V. renifolia*.

(2) Spur of the same length as the anther cells and extending between them. — *V. rotundifolia*, *V. canadensis*, *V. nuttallii*, *V. hastata*, *V. pubescens*, *V. scabriuscula*, *V. tripartita*.

(3) Spur extending 1.5 to 1.8 mm. below the anther cells. — *V. pedata*, *V. ovata*.

(4) Spur extending 2.3 to 3.6 mm. below the anther.

(*a*) Spur 0.78 mm. wide. — *V. arenaria*, *V. labradorica*, *V. striata*, *V. selkirkii*.

(*b*) Spur 1.5 to 1.8 mm. wide. — *V. delphinifolia*, *V. odorata*, *V. obliqua*, *V. palmata*, *V. sagittata*, *V. sororia*.

(5) Spur extending 9 mm. below the anther. — *V. rostrata*.

Whether these 30 are all good species or partly varieties or hybrids is not yet certain. Color in some species has been shown to depend on climate, and the same is true of caulescence and acaulescence. The pollen is much alike in all. In some cases systematists appear to have mistaken germinating pollen grains for hairs in the bottom of the flower. The shape of the mucilage cells may possibly turn out to be of some help in classification. They are readily stained in a solution of methylene blue. The author would be glad to monograph this genus, if material could be obtained. He desires fresh seeds of Viola from all parts of the world. His address is Philadelphia College of Pharmacy, Philadelphia, Penn.

DR. G. E. STONE: *The Influence of Electricity upon Plants.* — Various kinds of currents were employed and data showing the relative effect of each upon the growth of the plant were presented, also the effect of single stimuli for a period of one minute, hourly intermittent and constant stimuli were shown. A brief *résumé* of some of the more important results obtained by subjecting about 20,000 plants to electrical stimuli are as follows:

(1) The application of certain strengths of current for a short period of time (one minute or less) is sufficient to act as a stimulus.

(2) The process of germination is accelerated by electricity.

(3) Electrical stimuli give rise to an acceleration in the growth of the plant.

(4) Electrically stimulated plants do not respond immediately to the influence of the current. The latent period following stimulation is equal to about 25 minutes, or, in other words, it is about the same as that for heliotropic and geotropic stimuli.

(5) The reaction of the plant to electrical stimulation is confined to a narrow range in the current intensity. The plant reaction is manifested either in an acceleration or retardation of its metabolic activities; the nature of the response depends entirely upon the nature of the strength of the current employed.

(6) There is a minimum, optimum, cessation, and maximum stimulus.

(7) The excitation produced by alternating currents is more marked than that produced by direct currents.

(8) The increase of stimulus necessary to produce an equally noticeable difference of perception bears a constant ratio to the total stimulus intensity; the relationship existing between the perception and stimulus is expressed by the ratio 1:3 (Weber's law).

Dr. C. O. Townsend: *Germination of Spores after Long Exposure to Distilled Water.* — Spores of Mucor, Penicillium, and other fungi were placed in test-tubes which had been partly filled with distilled water. Some of the test-tubes were placed in the open air so that the spores were subjected to the changes in temperature incident to the changes of weather from day to day as well as to the changes in temperature between day and night. Other test-tubes were kept at a nearly constant temperature of 18° in diffused light; others at the same temperature were kept in the dark, and still others at 25° in the light. The vitality of these spores was tested from time to time by placing them upon a gelatine-sugar mixture in damp chambers. So long as the spores, which were exposed to external conditions, did not freeze, they retained their ability to germinate in the usual time — from 12 to 16 hours. After they had been frozen, however, they did not germinate under the conditions used. The other spores under investigation retained their ability to germinate for about six months. The time required for germination after the spores were placed upon the gelatine-sugar mixture did not materially change during this period. It should also be noted that the growth of the mycelia, as well as the ability of the fungi to form new spores,

did not vary in any marked degree from the growth and spore development of dry spores.

Dr. Erwin F. Smith: *Sensitiveness of Certain Parasites to the Acid Juices of the Host Plants.* — The author presented a tabular statement of the results obtained by inoculating acid nutrient solutions with bacteria parasitic to plants, *e.g.*, *Pseudomonas campestris*, *Ps. phaseoli*, *Ps. hyacinthi*, *Ps. stewarti*, *Bacillus amylovorus*, *B. oleæ*, etc. He was led to these studies by observing that the three yellow plant parasites first named spread very slowly through the parenchymatic tissues of their host plants. This is true in the field and in the greenhouse, and it also occurs when enormous numbers of the organism are injected into the parenchyma by means of hypodermic syringes. To fully realize the slow progress of these diseases they should be compared with such rapid diseases as pear blight, the brown rot of the potato, or the soft white rot of hyacinths, which often destroy large portions of the host in a few days. Two of these yellow organisms are vessel parasites, their entrance into the plant being favored by the alkaline juice of the ducts. In all three the restraining influence was believed to be, in great part, at least, the acid juice of the parenchyma. The detailed experiments confirm this view and show that there is a very wide difference in the susceptibility of bacteria to plant acids. All of the solutions were titrated with $\frac{N}{10}$ NaOH and phenolphthalein, so that their exact acidity is known. Those who wish details are referred to a forthcoming bulletin on the pathogenic properties and life history of *Ps. hyacinthi*, of which this paper will form a part.

Dr. Carleton C. Curtis: *Further Observations on the Relations of Turgor to Growth.* — Experiments were undertaken to determine (1) how soon growth would be renewed after a change in the concentration of the nourishing solution, and (2) to measure the turgor force at the moment of renewed growth. Three species of fungi were used — a Penicillium, a Mucor, and a Botrytis. These plants were grown in nourishing solutions and in the same with addition of 4, 9, 14, and 20 per cent nitrate of potash. Penicillium grown in the nourishing solution had a turgor force of 7.5, nitrate of soda being used as a plasmolyzer; when grown in 20 per cent nitrate of potash, it had a turgor force of 42.5. When transferred from the nourishing solution to the 20 per cent solution, growth was stopped from 8 to 12 hours. At renewal of growth the turgor was found to be normal for the 20

per cent solution, *i.e.*, 42.5. In changing from 20 per cent to 0, solution growth ceased, to be renewed again in 30 to 45 minutes. On this renewal of growth the turgor force was found to be normal for the 0 solution, *i.e.*, 7.5. Corresponding results were obtained with the weaker solutions. Thus, in changing from 0 to 4 per cent, recovery was effected in about 1 hour, the turgor force being 12, *i.e.*, normal for hyphæ growing in such a solution. In changing from 4 to 0, growth was renewed after about 15 minutes. Botrytis gave practically the same results. Mucor was much more sensitive. It has a lower turgor force and would not stand a change higher than a 4 per cent solution. In other respects it behaved like Penicillium and Botrytis. When nitrate of potash is used, turgor would seem to be a controlling force in growth. The checking of growth when the turgor is increased, as by change from a strong to a weak solution, corresponds to injury from cutting, *i.e.*, is in the nature of a shock, the length of time growth is inhibited depending on its severity.

Dr. W. F. Ganong: *Some Appliances for the Elementary Study of Plant Physiology.* — The author pointed out that investigation is indirectly aided by good elementary teaching, which diffuses its results and enlists sympathy and support, and as well attracts more and better students for the making of investigators. At the present time, too, there is a rapidly increasing tendency to introduce more physiological study into elementary courses in schools and colleges, which is producing a demand for simpler and less expensive physiological appliances. In elementary teaching it is qualitative results that are mainly sought, and hence much simpler and less exact appliances can be used than is possible in investigation where nothing less than the very best can profitably be employed. The author then exhibited and described some simple appliances developed in his physiological practicum in Smith College. These included a simple temperature stage, made of copper; an efficient clinostat ample for demonstrating the principles of geotropism, heliotropism, etc., constructed from clockwork; a simple and inexpensive self-recording Auxanometer; an Osmometer made from burettes and Schleicher and Schuell's diffusion shells; a very simple apparatus for demonstrating the exchange of gases in respiration; a special germination box; an advantageous method of preparing a potted plant for the study of transpiration, and a simple method of graduating roots, etc., with insoluble India ink, which is applied on a stretched thread along which it runs by capillarity.

PROF. D. T. MAC DOUGAL: *Symbiosis and Saprophytism.* — It is customary to designate all chlorophylless, seed-forming plants, which have no nutritive connection with other vascular species, as saprophytes, or more exactly as holosaprophytes (allotropic or heterotropic forms, according to Pfeffer's classification), and others of similar physiological tendencies as hemisaprophytes (mixotropic forms), without regard to the nutritive unions formed by the roots or absorbing organs, as in mycorhiza, tubercles, and other associations. It is obvious that the terms *saprophyte* and *holosaprophyte* should be applied to those species only which derive their food supply from organic products directly without the activity of chlorophyll and unaided by other organisms. In this sense, which appears to be the only meaning admissible, the holosaprophytes include numerous bacteria and fungi, but, so far as previous investigations show, only one seed-forming genus, Wullschlægelia. As the result of some work now in press, the waxy white orchid of the northwest, *Cephalanthera oregana* Reichenb., should be added to this category.

As a consequence of the acceptance of the limitation of the term holosaprophyte, as given above, all those species furnished with mycorhiza or tubercles, or which enter into direct mechanical or nutritive associations, must be classed as symbionts.

It is a matter of common knowledge that seedlings are holosaprophytic in the stage in which they are wholly dependent upon the reserve material in the endosperm, and, in general, during the period previous to the formation of chlorophyll. This period is practically obliterated in those species in which chlorophyll is formed in the seed. The capacity for the absorption of humus products has played an important part in the production of the minute seeds of the orchids and other groups of similar physiological organization, and the extension or retention of this capacity throughout a greater or less portion of the life of the sporophyte has resulted in varying stages of true saprophytism. Although, so far as known, this period has been extended to include the complete life history of this generation in only two seed-forming genera, the results of recent investigations show that practically all green plants are capable of taking up and using a varying proportion of humus products. Only those which show a marked extension of this capacity should be classed as hemisaprophytes. The hemisaprophytes among seed-forming plants would therefore consist chiefly of carnivorous species, whereas nearly all of those now included are, in fact, more or less symbiotic by means of mycorhiza, tubercles, etc.

PROF. D. T. MAC DOUGAL: *Influence of Inversions of Temperature and Vertical Air Currents upon the Distribution of Plants.* — The soil and the air resting upon it receive the same amount of heat during the day, but at sunset the temperature of the earth is slightly higher than that of the air. At this time both begin to lose heat, but the soil cools much more rapidly than the air. The air is a poorer conductor than the soil, and hence the layers of air resting immediately upon it are cooled by radiation and conduction to the cold surface to a temperature far below that of the body of the air a few meters above. The consequences of this inversion are to be seen in the effects of late spring frosts, when the lower branches of a tree or shrub may be injured while the upper ones will be unharmed.

This nocturnal inversion of temperature occurs over almost all land areas, but is most marked in regions of low relative humidity. In North America it is most pronounced on the elevated plains, where it is a distinct but heretofore unrecognized factor in determining the boundaries of life zones.

In broken countries the cooling of the surface layers of air results in its contraction and increase in weight, and, as a consequence, the cold air thus formed on elevated mesas, ridges, and hilltops flows down the slopes into the depressions and valleys, filling the latter with a deep layer of cooled air while a constant supply of warm air settles down on the highlands. As a result of this action, the hills and lower mountain ridges have a much more equable temperature than the valleys and cañons. Thermographic records obtained at Flagstaff, Arizona (in a valley 6862 feet above sea level), and on Observatory hill (on the west side of the valley at an elevation of 7162 feet), in June and July, 1898, show that the minimum temperature of the valley was 15° to 27° F. lower than that of the hill at the same time.

If the slopes of the hill or mountain are several thousand feet in vertical extension, the descending current may sweep down so rapidly as to actually increase in temperature and reach the valley below as a warm wind. Regular currents of this sort are rare. The "Chinook" or "Foehn" owes its warmth to this cause.

Again, the upward movement of the air, under the influence of the sun's rays during the day, results in an expansion and absorption of some of the heat, so that these currents reach the highlands at a lower temperature than the air resting on such areas, and tend to an equalization of the temperature. At the stations mentioned, the maximum temperature of the hill was always 4° to 6° F. below that

of the valley. Thus the total daily variation on the hill was 20° to 30° F. less than that of the valley.

Now, the northern advance of southern plants is governed by the sum of the positive temperatures, or the sum of the temperatures, above that at which plants and animals start into activity in the spring, taken throughout the entire season of growth and reproduction; and the southward distribution of northern plants is governed by the mean temperature of a brief period of a few weeks during the hottest part of the summer. It is obvious, therefore, that, as the positive temperature of the hills and mesas is greater than that of the valleys, the southern plants should find their way farthest north along the minor ridges and hills. At the same time the average temperature of the valleys is lower than that of the ridges, and hence the northern flora should reach its southernmost limits down valleys heading up in mountains and mesas favorable to the development of the greatest effects of inversions of temperature.

The influence of inversions of temperature is, therefore, to make extremely sharp deflections of the zonal boundaries, which may extend only a short distance locally, or which may reach over a hundred kilometers from the general limits of the zone. This conclusion is supported by my own observations in Arizona, and by facts concerning the flora and fauna of New Mexico and Texas cited by Professor Townsend.

Ascending currents of air also cause changes in humidity which exercise an extremely local influence on the distribution of the moisture-loving forms. As the diurnal warm current ascends the slope of a hill or the walls of a cañon, it expands and loses heat, and at the same time the dew point is lowered or the relative humidity is increased. When the current reaches the level of the highland it flows over it as a moist and cool wind. It is gradually warmed again, however, and its dew point raised in a few kilometers, progress. As a result of this action the area bordering upon a cañon, gulch, or valley offers a much more humid atmosphere than regions more removed, and hence these portions are most suitable for the moisture-loving species.

This principle is beautifully illustrated by the distribution of *Razoumofskya vaginata* (Willd.) Kuntze, which is parasitic on *Pinus ponderosa* var. *scopulorum* in this region. Although native of a semi-arid region, the parasite is most successful in the germination of its seeds and the attachment of the seedlings to the host plant in a humid atmosphere. While it is found throughout the pine belt, it is most

abundant along the margin of mesas, and along hills bearing a certain topographic relation to adjoining valleys. The most striking example of this fact is to be seen along the mile-deep cañon of the Colorado river. Here the heated air rising from the river bed, under the rays of a sub-tropical sun, loses 20° F. of heat in its vertical ascent of over a kilometer. As a consequence it pours over the rim of the mesa heavily laden with moisture, and the Razoumofskya is quite abundant in a belt a kilometer in width running parallel to the rim, while it is comparatively infrequent at greater distances from the cañon.

PROF. CONWAY MAC MILLAN: *Notes on the Reproduction and Development of Nereocystis.* — The author described the great bladder kelp, *N. Lütkeana*, which is abundant in the swift tide-water channels of Puget sound, and which frequently reaches the enormous length of 80 to 100 meters. He has studied several hundred specimens (collected by Miss Josephine Tilden) with special reference to structure and early stages of growth. He exhibited a plant less than 1 millimeter long, and also one about 10 meters long. The latter consisted of a hollow green stem several centimeters in diameter at the base where it was anchored to the mud or rocks by a mat of large branched rhizoids, about 2 decimeters broad. This green stem gradually enlarged, until, at a distance of about 3 meters from the rhizoids, it very gradually expanded into a bulb 8 or 10 centimeters in diameter. This was crowned by the broad, thin, and very long, floating green laminæ. The figure given in *Die Natürlichen Pflanzenfamilien* is not a very good one. At low tide the sea is dotted with these floating bulbs, and the plants are so strong, in mass, that fishing boats may be anchored to them, while smaller boats are sometimes capsized by them. As is well known, the Aleuts formerly used the flexible hollow stem to siphon water from their boats.

Spores in sporangia are the only known reproductive bodies. Calosities occur on old plants. Sieve tubes are present. They are pulled out by the elongation of the stem, and are undoubtedly converted into gelatin. They are morphologically different from trumpet hyphæ. No evidence of protoplasmic connections was obtained. The cryptostomata disappear on old plants. The cleft in the lamina arises not as a tear, but is started by the deliquescence of a single row of cortex cells just below the epidermis. As the result of this continued deliquescence an ever deepening fold arises which finally cuts the lamina into two. Many slides, specimens, photographs, and drawings were exhibited.

DR. E. A. BURT: *The Formation and Structure of the Dissepiment of Porothelium.* — The author traced the development of the fructifications of *Porothelium fimbriatum* Pers. from their origin as papillæ, through the pore, to the tube stage, in the latter stage contrasting the structure of the dissepiment where the tubes are closely crowded together with its structure where they are more scattered.

This fungus occurs as a thin, closely adhering layer on dead limbs, etc. The papillæ are solid throughout their early history. They develop into pores by the more rapid growth of some parts than of others. In some species, as *P. friesii*, the papillæ are buried; in others, regarded as higher in rank, the papillæ are buried only in early stages of growth.

DR. ERWIN F. SMITH: *Gelatin Culture Media.* — By means of a chart, photographs, and paintings the author called attention to the diverse and confusing results different individuals working with the same organism might reach with gelatin culture media. Our knowledge of this very useful medium has increased greatly in recent years. The best paper in English is by Geo. S. Fuller, "On the Proper Reaction of Nutrient Media for Bacterial Cultivation," *Journal of the Am. Public Health Association*, October, 1895, Concord, N. H. The most confusing things are: (1) the fact that gelatin which reacts neutral or moderately alkaline to litmus is still acid to phenolphthalein and often exerts a restraining influence on bacteria, especially certain parasites; and (2) the fact that grape sugar or cane sugar in gelatin, while stimulating growth, often entirely prevents liquefaction, so that one may be dealing with a liquefying organism without knowing it. Some liquefiers are more sensitive than others, and it is not yet known how small an amount of sugar will restrain the most sensitive forms.

All gelatin media should be rendered neutral to phenolphthalein, and it would be well, for the present at least, to use beef broth free from muscle sugar in making gelatin. Possibly the restraining influence of sugar may also be of some use in making gelatin plate cultures of slow-growing forms which are mixed with rapid liquefiers, and which under ordinary circumstances run over and spoil the plate before the desired form has been able to grow.

All gelatin media should be titrated against $\frac{1}{10}$ or $\frac{1}{20}$ normal caustic soda, and then the desired amount of acid or alkali added in the form of double normal solutions so as not to much disturb the proportion of fluids and solids. The melting point depends on the amount of gelatin added, the length of the steamings, and the amount

of acid or alkali added. All of these disturbing influences should be taken into account. The per cent of gelatin used and the melting point of the prepared media should always be stated.

Working with gelatin of varying grades of acidity and alkalinity, prepared according to Fuller's scale, *e.g.*, with + 50 + 40 + 30 + 20 + 10. 0 − 10 − 20 − 30 − 40 − 50, with interpolations and extension of the scale, if necessary, it is possible to obtain curves of growth decidedly different for different species, even those which are morphologically much alike and which behave the same on nutrient agar. On this scale the + signs indicate acidity and the − signs alkalinity, and the figures denote, per liter of nutrient gelatin, the number of cubic centimeters of the normal acid or alkali which would have to be added to render the medium exactly neutral to phenolphthalein. The litmus neutral point of gelatin is approximately + 25 of this scale. The varying behavior of *Pseudomonas campestris* in the same gelatin with different quantities of caustic soda is shown on the accompanying plate.

PROF. CHARLES E. BESSEY: *Relative Infrequence of Fungi upon the Trans-Missouri Plains and the Adjacent Foothills of the Rocky Mountain Region.* — A study of the fungus flora of the Trans-Missouri Plains, extending over a period of fourteen years, has shown that while the number of species is large the number of individuals is relatively small. This is in marked contrast to the flowering plants, where the number of individuals is relatively high as compared with the number of species, especially in the herbaceous groups.

Of the principal groups of fungi, the Phycomycetes are usually quite infrequent, appearing in considerable numbers in wet years only; the Perisporiaceæ are, likewise, not usually abundant, although occasionally becoming very abundant, as with the Phycomycetes: the Pyrenomyceteæ are numerous as to species, but ordinarily infrequent as to individuals, with, however, some marked exceptions, as the ergot of Agropyron and Elymus (*Claviceps* spp.); the Discomyceteæ are rare, excepting in the most favorable of seasons: the Uredineæ are usually abundant, although the number of species is not exceptionally large; the Ustilagineæ are not numerous in species nor commonly abundant in individuals, excepting for three or four which affect the cultivated cereals; of the "Fungi Imperfecti" the number of species is relatively large, while again the individuals are relatively infrequent.

The higher fungi, including the Basidiomyceteæ, show this infrequence of individuals still more emphatically; the Gasteromyceteæ are ordinarily infrequent, with now and then an exception, in favorable periods, as when *Ithyphallus impudicus* springs up in great abundance; the Hymenomyceteæ are normally rare, although the number of species is fairly large.

Apparently this relative infrequence of the fungi is due to the greater aridity of soil and air, resulting in less favorable conditions for the germination of the spores, as well as for the subsequent development of the plants themselves.

B. M. DUGGAR AND F. C. STEWART: *Different Types of Plant Diseases due to a Common Rhizoctonia.* — Rhizoctonia was established by De Candolle, in 1815, as a generic name for certain sterile fungi. Many species have since been described, all of which may be subterranean parasites. There is no certain evidence connecting these forms with fruiting stages. Studies in plant diseases during the past few years have brought together some very different types of disease due to Rhizoctonia, viz.: (1) damping off of seedlings of many kinds; (2) a rot of radishes; (3) a root-rot of beets; and (4) a stem-rot of carnations. Experiments have proved conclusively that the root-rot of the beet and the stem-rot of the carnation are interchangeable, and indicate that the sterile damping off fungus is also very probably the same species slightly modified physiologically. Under certain conditions Rhizoctonia forms sclerotia on the host (carnation) and also on culture media. On the beet brown mycelia but no sclerotia develop. The mycelium is peculiar in its method of branching, and in the formation of certain hyphal elements which function as spores. The germ tubes of these nearly iso-diametric elements often bore through the septa of empty cells to which the germinative cells are still attached. The fungus grows well in acid media, but is very sensitive to alkaline media, and this suggests methods of treatment, *i.e.*, by liming the soil. The similarity of all of the forms studied suggests that some other so-called species may likewise prove to be the same organism, and at present the plant cannot be referred to a definite species.

F. C. STEWART: *The Stem-Rot Diseases of the Carnation.* — Under the name "stem-rot" or "die back" at least two distinct diseases have been confused. One is caused by Rhizoctonia; the other is due to a Fusarium and is, perhaps, identical with Sturgis's carnation

stem-rot. Both diseases are common in New York in the field and in the greenhouse.

The Fusarium attacks chiefly the stem and larger branches, discoloring the wood and killing the cortex. The stems rarely become soft rotten. The plants die gradually, with yellowing and drying of the foliage. The fungus fruits rarely on the outside of stems, but more frequently in the cambium and medulla of stems long dead.

The Rhizoctonia causes plants to wilt suddenly by rotting the stem at, or just below, the surface of the soil. The cortex readily separates from the wood. The medulla is attacked quite early, becoming water-soaked in appearance (or corky, when dry) and filled with hyphæ.

THE OSSICULA AUDITUS AND MAMMALIAN ANCESTRY.

J. S. KINGSLEY AND W. H. RUDDICK.

THE various students who have investigated the mammalian ear-bones have arrived at the most diverse views as to their homologies, and it was with the idea of satisfying ourselves which of the several accounts of these structures was correct that we began our studies. As we progressed, however, it became apparent that these ossicles threw no little light upon the broader question of the origin of the mammalia. In our final paper we will give full details of all of our observations, as well as a discussion of the results of other students. The present paper states our views of the homologies of these ossicles in a brief manner and shows the bearings which these have upon the problem of mammalian descent. The material which we have studied has been embryos and larvæ of Amphiuma, Pipa, Ichthyophis, Sceleporus, rat, and pig, and our methods have been largely those of wax reconstruction from sections.

Distinct auditory ossicles occur in no fish-like form, but from urodeles to man, in one shape or another, they are present in all forms. In urodeles there is a large fenestra ovalis in the outer wall of the otic capsule, and in this, connected to its margin by membrane, is a cartilaginous plate which is usually called the stapes. It is unnecessary for our present purpose to consider whether this element is formed from the otic capsule, or is the homologue of the hyomandibular of the fishes, or, again, is an independent structure. In most urodeles this stapes is attached to other structures by ligaments alone, but in Amphiuma as well as in Plethodon (*teste* Winslow) and in all Cæcilians which have been studied, the stapes articulates directly with a stapedial process which is given off from the posterior side of the quadrate. At first this quadrate is free from the cranium, and is connected only with the slender Meckelian car-

tilage of the lower jaw. A little later the quadrate extends to and fuses with the otic capsule a little above and in front of the fenestra ovalis. This we may term the urodele type of auditory ossicles, although it is a question as to how far they serve as a sound-transmitting apparatus, the tympanum being entirely absent in the urodeles. These features, then, are the possession of a quadrate which acts as a suspensor of Meckel's cartilage, and at the same time articulates with the stapes. It may be noted, in passing, that in the Cæcilians the stapes is perforated, much as in mammals, for the passage of the stapedial artery, a feature which adds to the probability that this element is homologous throughout the pentadactyle vertebrates.[1]

Of the anura we have studied Pipa, and our results here are much like those of Gaupp upon Rana. In both of these genera the essential features from our present standpoint show no affinities with the urodeles, but resemble rather those of the sauropsida, and hence a description of the relations in a lizard will answer present purposes.

In Sceleporus, which we take as the sauropsidan type, and in which we have studied several stages of the conducting apparatus, the auditory chain consists of a stapes lying in a fenestra ovalis, and, connected with this, a columella consisting of at first a cartilage rod extending horizontally outward into the tympanic membrane. When first differentiated, the shaft of this columella lies in the mesenchyma posterior to the entodermal diverticulum, the distal end of which expands later to form the tympanic cavity. In other words, *the columella is postspiracular.* Another point of considerable importance, and one which has been neglected by most previous students of the auditory ossicles, is the relation of the stapedo-columellar tract to the adjacent nerves. The facial nerve, after leaving the cranium, passes backward just outside the otic capsule, running above the stapedo-columellar shaft. At the most posterior point of its excursion the facialis gives off a nerve, the chorda

[1] In spite of this similarity between the auditory chains of Cæcilians and Amphiuma, we do not agree with Cope that the Cæcilians have descended from Amphiuma, nor with the view of the Sarasins that Amphiuma is a neotænic gymnophione. The senior author hopes to present his views upon these points at an early date.

tympani, which runs forward *above* the shaft of the columella and on the medial side of the quadrate, to extend into the lower jaw, together with the mandibular branch of the trigeminal nerve. With further development the columella seemingly invades the tympanic cavity. In reality the cavity in its expansion extends around the rod, which, however, remains connected with the posterior tympanic wall by means of a fold of the tympanic epithelium and the enclosed mesenchyma. The quadrate, contrary to what obtains in the urodeles, does not articulate with the stapes, nor is it connected, except by liga-

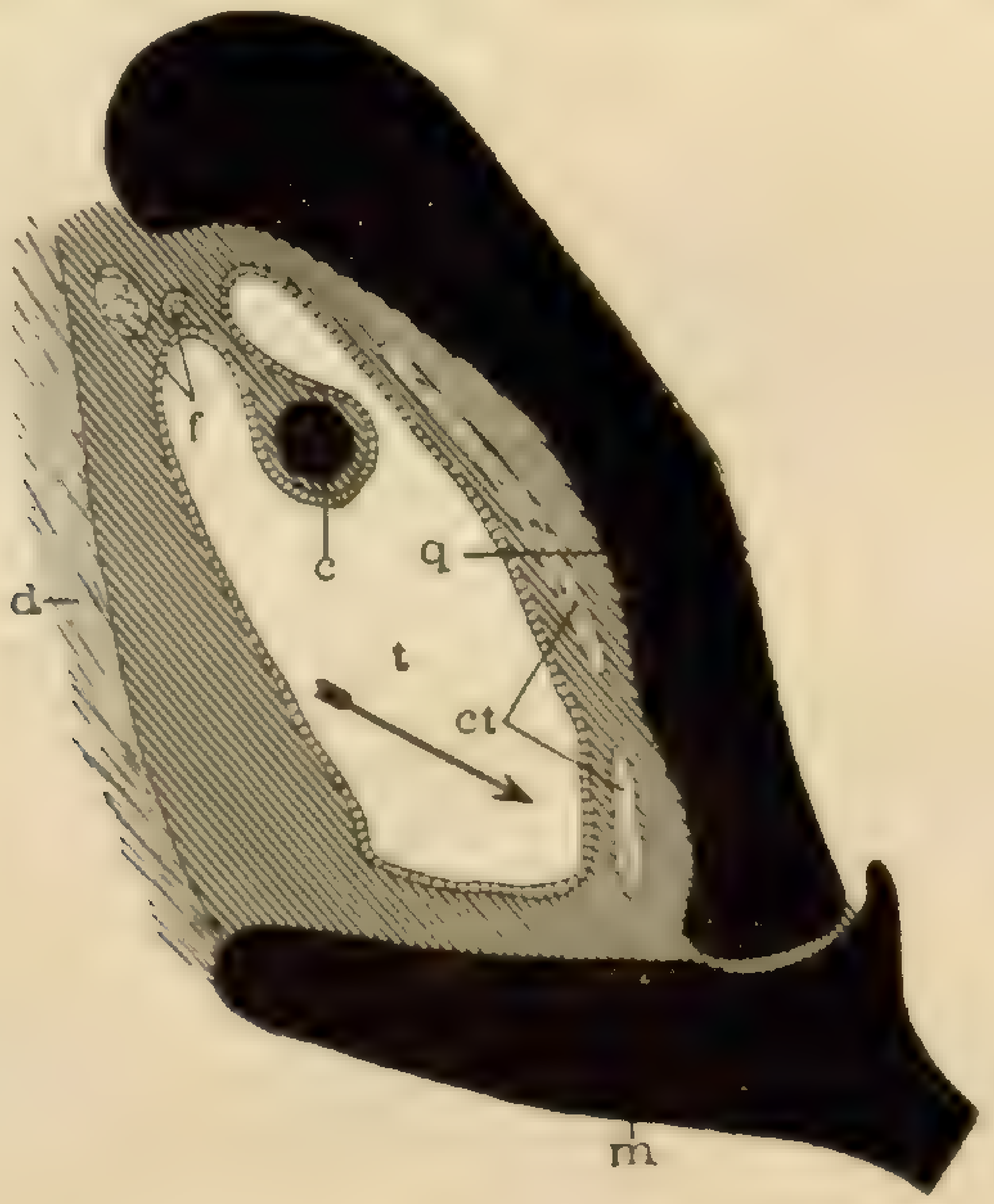


FIG. 1. — Section through the tympanic region of an embryo of *Sceleporus undulatus*, showing the columella, *c*, entering the tympanic cavity from behind; the arrow points towards the tip of the snout, the cartilages are black. *d*, digastric muscle; *ct*, chorda tympani; *f*, facial nerve; *m*, head of Meckel's cartilage; *q*, quadrate; *t*, tympanic cavity.

ment, with the sound-conducting apparatus. Its sole function is that of a suspensor of the lower jaw. The sauropsidan type, then, may be characterized as consisting of a stapes and a columella which form the auditory chain, the columellar shaft being post-trematic in origin, while the quadrate is outside of and apart from the sound-conducting apparatus.

All other questions regarding this apparatus in the sauropsida must be ignored here — the question of the homologies of the stapes, the relations of both stapes and columella to the hyoid and hyomandibular, etc., as well as discussions of muscles; we can only call attention to the fact that there is some

evidence to show that that portion of the columella which lies within the tympanic membrane may possibly be homologous with the manubrium of the mammalian malleus, to be described below.

In speaking of the auditory ossicles of the mammals, it will be necessary to go into more detail, since, while the different features of development have been described several times, there is great diversity of opinion as to the homologies of the parts concerned.

In the pig the ossicula auditus and related parts can first be made out in embryos measuring about eighteen millimeters in

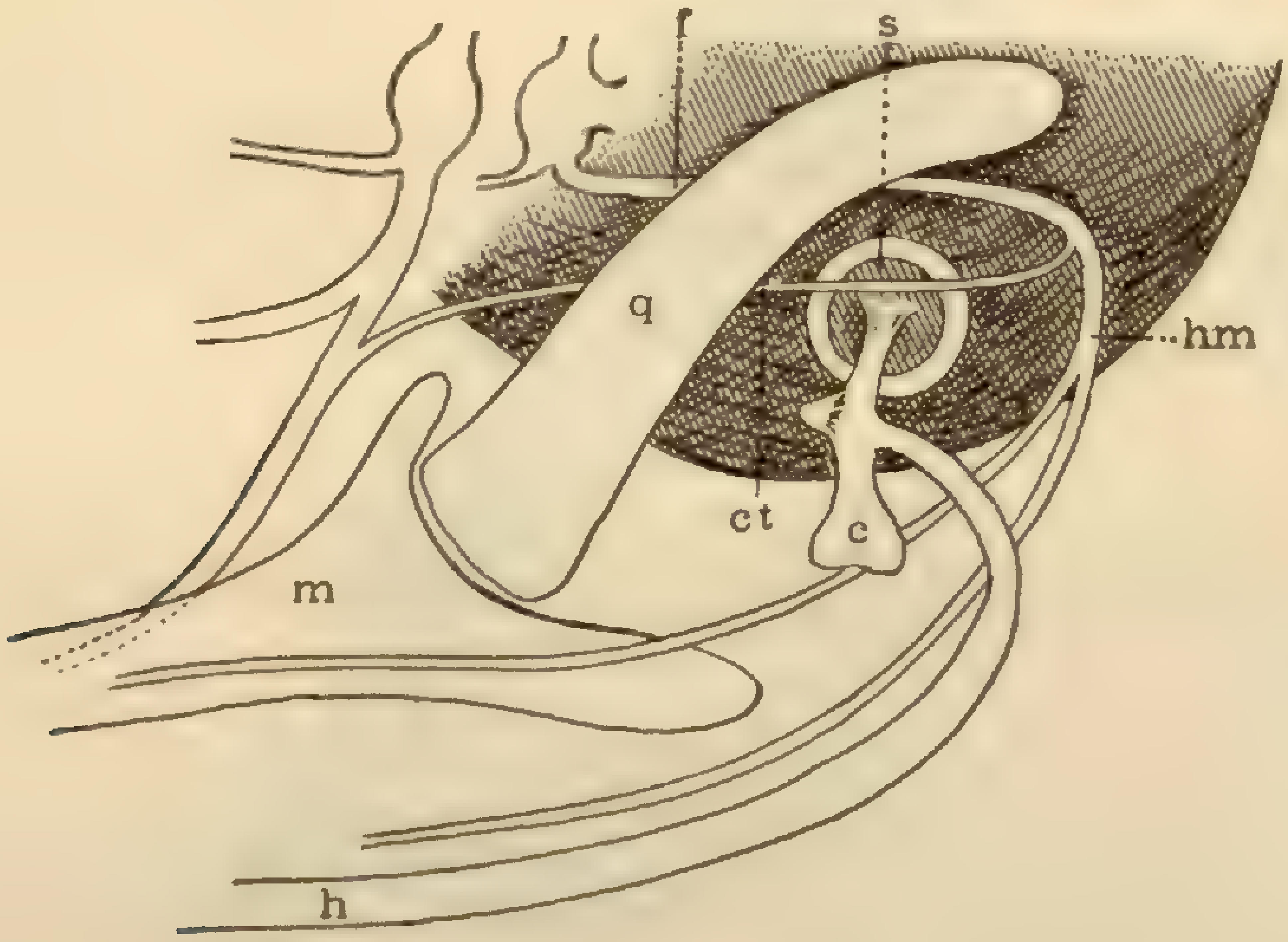


FIG. 2. — Diagram of otic region in Sceleporus embryo: *c*, columella; *ct*, chorda tympani; *f*, facial nerve; *h*, hyoid; *hm*, hyomandibular nerve; *m*, head of Meckel's cartilage; *q*, quadrate; *s*, stapes in foramen orale; the otic capsule shaded.

total length, and sagittal sections give the clearest pictures. In embryos of this size the otic capsule has not begun to differentiate, the utriculus, sacculus, and semicircular canals being imbedded in a homogeneous matrix of mesenchyme, which nowhere shows that concentration of nuclei so characteristic of procartilage formation. The stapes, on the other hand, is well outlined as a mass of procartilage formed around the stapedial artery, the mass having the form of a ring rather than the stirrup shape of the adult. Ventral to the stapes is the Eustachian cleft, which as yet shows no differentiation into tympanic cavity and tube. This cleft extends outward for some distance above and parallel to the inner end of the external

meatus. The tissue between these two tubes is to form the tympanic membrane, its plane being now nearly horizontal instead of oblique, as in the adult. In this membrane is formed a rod of procartilage entirely unconnected with any other skeletal structure, the Anlage of the manubrium mallei. In front this procartilage gradually shades off into the looser mesenchyme between it and the mandibular arch, while behind it is very sharply delimited from the undifferentiated tissue lying between it and the hyoid.

In front of the Eustachian cleft and external meatus is another mass of procartilage, the anlage of the mandibular arch. At first it consists of a continuous stroma, which extends proximally and dorsally to a point just in front of the stapes, distally into the lower jaw. This procartilage rod is not equally dense throughout, but at the level of the future tympanic membrane the nuclei are less crowded than they are above and below. This indicates a division which later becomes more marked, separating a proximal element, the incus, from a more distal portion which will give rise later to a proximal body of the malleus and its processus longus and a more distal rod of cartilage which extends into the lower jaw. So far, with the exception of the separate origin of the manubrium of the malleus, all who have approached the problem of the mammalian ear-bones from the developmental standpoint are in agreement. The differences of opinion are regarding the nature of the incudal element.

In the pig embryo, twenty millimeters long, several changes have been introduced. Chondrification of the otic capsule is well advanced, the foramen ovalis being formed around the base of the stapes in such a way that it lies within the opening. In the stapes itself the process of chondrification has set in, while outside the junction of its crura arises a short process which articulates with a stapedial process of the incus. The body of the incus is now an elongate plate with rounded extremities, the whole occupying a vertical position. The dorsal end extends up to, and may be said to articulate with a depression in the outer wall of the otic capsule, just above and outside the foramen ovale. Below, the stapes also articulates with the body of the malleus. The stapedial process of the incus is a slender

rod, smaller than the body, which extends backwards and slightly downwards to the stapes. From the body of the malleus a strand of cartilage has extended backwards and has fused with the manubrial cartilage noticed above, the whole forming the manubrium of the adult. Distally, the mallear cartilage is still continuous with the rest of Meckel's cartilage, extending into the lower jaw.

At this stage we can recognize clearly the three[1] ossicles and their processes of the adult ear. So far they all lie outside of, and, so far as incus and body of the malleus are concerned, in front of the tympanum; they are prespiracular. Hence it follows, as certainly as any morphological conclusion can be drawn, that they cannot be homologized with the columella and its derivatives in the sauropsida, as has been attempted by Albrecht, Dollo, and others. This lack of homology is still further emphasized by the course of the chorda tympani, which in its course passes *below* the articulation of incus and stapes, and then forward on the inner or medial side of the incus to the fifth nerve. It may, however, be possible that the manubrial portion of the malleus is homologous with the distal portion of the columella.

The question now comes up for decision, What are the homologues of incus and malleus in the lower vertebrates? All recent students are in agreement that the body of the malleus is derived from Meckel's cartilage, for it retains its connection with the cartilage of the lower jaw for some time; but whether it is the articulare of non-mammalian groups can only be decided later, after a discussion of the incus. Concerning this latter bone two views are held at present, for no recent student has attempted to recognize in it the hyomandibular. According to one view the incus is the quadrate, while according to the other it arises from the proximal end of Meckel's cartilage, while the quadrate, according to this same view, has fused with or has become lost in the squamosal region of the mammalian skull.

The greatest objection which has been advanced to the first

[1] The os-obiculare or lentiforme occurring between the incus and stapes is a later structure without morphological significance.

of these homologies — the incus-quadrate homology — is that it must necessarily follow that the articulation of the lower jaw with the cranium in the mammals cannot be homologous with the articulation in the lower vertebrates, and that it is difficult to imagine this transfer of functions from one point to another. The weight of this objection we admit, but we shall endeavor to show a little later that no matter what view one takes of the fate of the quadrate in the mammals, there is this same problem of the formation of a new articulation to be met, for it is impossible, upon any basis, to homologize the articulation of the lower jaw in the mammals and the non-mammalian groups.

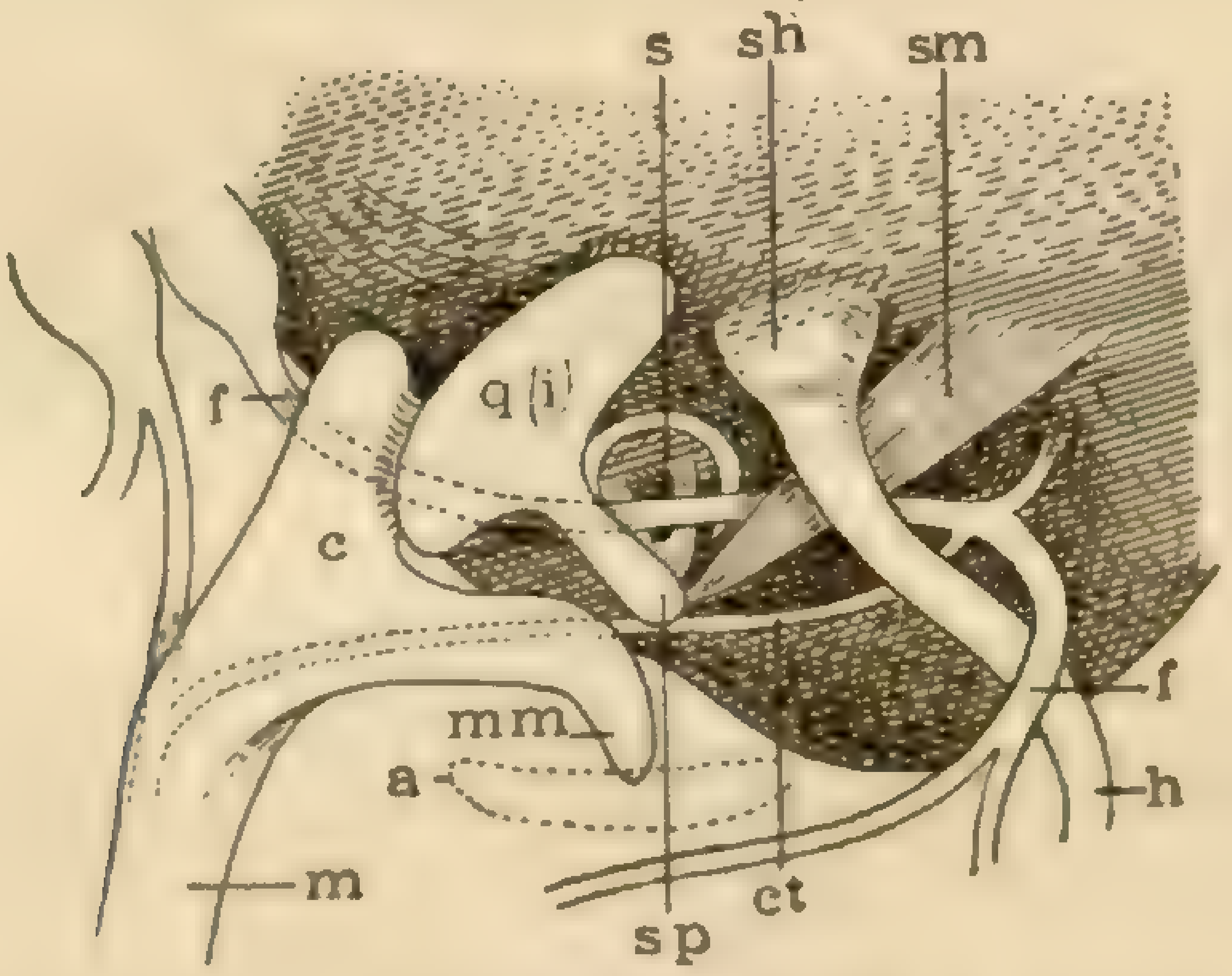


Fig. 3. — Diagram of otic region in pig embryo: *a*, position of external meatus; *c*, body of malleus; *ct*, chorda tympani; *f*, facial nerve; *h*, hyoid; *m*, Meckel's cartilage (processus longus); *mm*, manubrium mallei; *q* (*i*), quadrate (incus); *s*, stapes; *sh*, styloid process of hyoid; *sm*, stapedial muscle; *sp*, stapedial process of quadrate.

In all ichthyopsida and sauropsida the articulation of the lower jaw with the cranium is in reality an articulation between the quadrate and Meckel's cartilage, and even when it becomes an osseous articulation it is an ossification of the cartilages which affords the articular surfaces. In the mammals, on the other hand, Meckel's cartilage does not approach in any way to the glenoid fossa. The mandible forms around the distal portion of Meckel's cartilage as a membrane bone, and its ascending ramus grows away from the cartilage towards the glenoid fossa. So it is evident that the mandibular part of the articulation in the mammals is not formed by the Meckel's cartilage. How about the fusion of the quadrate in the squamosal, as maintained by Peters, Albrecht, and Cope? Development shows us not the slightest trace of cartilage in the region of the squamosal;

there is nothing but membrane bone. Besides, the proper position for the quadrate is at the proximal end of Meckel's cartilage. But Meckel's cartilage extends far back of the glenoid fossa, and one cannot readily imagine any reason for the transfer of the quadrate from one position to another. In a word, it is as incumbent upon those who claim that the quadrate has been lost in the squamosal region as upon those who recognize the quadrate in the incus, to explain the formation of a new articulation in the mammals.

An easily accessible figure will illustrate these points: Fig. 254 on p. 467 of Bell's translation of Gegenbaur's *Comparative Anatomy.* If the articulation of the lower jaw of mammals be homologous with that of lower vertebrates, then Meckel's cartilage (*p*) should run up into the glenoid fossa. If the incus (*i*) be the proximal end of Meckel's cartilage, then the quadrate should be sought between it and the cranial wall immediately adjacent. It is difficult to imagine how the quadrate could be translated from the point crossed by the "leader" from *i* to a point in the glenoid fossa crossed by the "leader" from *p*.

If, on the other hand, we suppose that the proximal end of Meckel's cartilage be represented by the body of the malleus, then the incus is in just the proper position for the quadrate; and the proportionally large size of this element in its earlier stages shows that it must have been of large size in the ancestral form. Then, again, in the embryo this incus acts as a true suspensorium of the lower jaw, while its connection with the stapes is of secondary size. In short, it fulfills every condition demanded of a quadrate in position and relation to other parts, and we doubt if its nature would have been questioned were it not for the hypothesis that the mammals had descended from the theromorphs in which the squamosal as well as the quadrate enters into the formation of the articular surface for the lower jaw.

One objection to the view that the incus is the quadrate is based upon the fact that it does not appear from the first as a discrete element, but is differentiated from a continuous stroma. This objection loses much of its force when we consider that

both Meckel's cartilage and the palatoquadrate of the elasmobranchs arise from a continuous cord of cells, and only with the process of chondrification does differentiation occur. In the digits the separate phalanges are likewise developed from a continuous mass of procartilage cells. In the light of all the evidence we feel impelled to agree with the majority of the embryological students who have studied the question and to regard the incus as the quadrate.

It appears to us that the relations of these ear-bones throw no little light upon the question of the origin of the mammals, or at least of the so-called higher mammals, since it is not beyond question that the mammals are a monophyletic group. For many years it was the general supposition that the mammals have descended from the Amphibia. Then came the discovery of the meroblastic ova of the monotremes, and the almost simultaneous announcement of the recognition of mammalian features in the theromorphous reptiles. Then for several years the prevailing view was that the mammals must have had a reptilian ancestry; but the pendulum began to swing backwards. The difficulty of the double occipital condyle remained. Hubrecht has pointed out the difficulty of deriving the mammalian ovum, with its peculiarities of segmentation, gastrulation, and especially its fœtal envelopes, from the sauropsidan type, while these can readily be evolved from the amphibian egg. Maurer has shown that it is impossible to compare the hair, so characteristic of mammals, with any known structure in reptiles; while, on the other hand, he has pointed out the close resemblances even in structural details between hair and the epidermal sense organs of the Amphibia.

Now, when we consider the ossicula auditus we see the impossibility of deriving those of the mammals from those of the reptiles. As we have shown, the shaft of the columella in the reptiles is postspiracular and is below the chorda tympani, while the incus and the body of the malleus are prespiracular and are above and outside of the chorda tympani. On the other hand, the mammalian ear-bones with all their peculiar features (the manubrium of the malleus excepted) are derivable from those of some urodele-like form. In the urodeles, as in mam-

mals, we find an articulation of stapes with quadrate, while in the reptiles no such articulation occurs.

Another fact which has a bearing upon the question of the origin of the mammalia has not, so far as we are aware, been referred to. In the urodeles[1] there develop a pair of thoracic ducts, one duct emptying into the venous system on the right side, the other into the left, near the heart. Of these ducts, the left is from the first the larger, while a little later the right completely disappears, leaving the left as the functional duct of the adult. This disparity in size from the first would show that this left-sided condition had persisted for a long time. In the mammals, as is well known, the left thoracic duct alone is functional, while in all sauropsida it is the right that persists. It is, therefore, impossible to derive the mammalian conditions from those found in any existing reptile, but of course one cannot say but what the earlier reptiles had this part of the lymphatic system paired. However, the conditions in the urodeles are suggestive.

We would not be understood to derive the mammals from any true urodele stock, but from some ancestor not widely removed from them. The urodeles, as we know them to-day, are a degenerate group, possibly descendants from terrestrial forms, and the lowest of the group, like Necturus, etc., have departed most widely from the ancestral type. The urodeles have lost many cranial bones; they have reduced the ribs, they have lost entodermal gills and gained those of ectodermal origin; they have lost the Eustachian tube, but they have retained many features which make them extremely interesting in connection with all phylogenetic speculations.

If, now, we advocate the amphibian origin of the mammals, we must consider the arguments of those who would derive them from the theromorphous reptiles. The chief of these are as follows:

In certain theromorphs, as in most mammals, there is a heterodont dentition; incisors, canines, and molars being differentiated. This, however, is not conclusive, since a heterodont

[1] For our knowledge of the development of the lymphatic system of the urodeles we are largely indebted to the unpublished investigations of Dr. F. D. Lambert.

dentition is not extremely rare in the non-mammalian vertebrates, which are certainly far removed from the mammalian line. On the other hand, the theromorpha have single-rooted teeth throughout, while certain of the dinosaurs have them with two roots. Heterodont dentition may easily be explained by parallel development from similar conditions.

In the theromorphs, as in the higher mammals, the coracoid is united to the scapula. This point is as favorable to the amphibian as to the theromorphous ancestry, since a similar state of affairs occurs in certain existing urodeles.

In theromorphs, as in mammals, there are bicipital ribs, one head articulating with the neural arch (diapophysis), the other with centrum or intercentrum. Here again the urodeles will fill the bill.

In the theromorphs, as in many mammals, there is an entopicondylar foramen in the humerus. This seems a feature of minor importance, since it is lacking in many mammals, while it is developed in some forms (*e.g.*, Hatteria) which cannot have had a theromorphous ancestry.

In the theromorpha, ischium and pubis fuse to form an innominate bone. This feature also occurs in certain urodeles as well as in some other reptiles.

In certain theromorphs (Clepsydrops) there is a differentiation of calcaneum and astragalus, recalling the relations in the mammals. Unfortunately, almost nothing is known of the foot structure in other theromorphs, and the resemblances pointed out in Clepsydrops are not conclusive. In all other sauropsids there is a strong tendency towards the development of an intratarsal ankle joint. Certainly the mammalian tarsus could have been derived directly from that of the Amphibia instead of indirectly through the theromorphs.

There is one serious objection to the theromorphous ancestry of the mammals upon which sufficient weight has not been placed. This view assumes that the suspension of the lower jaw in the theromorphs is, at least in part, homologous with that in the mammals. It assumes that the glenoid fossa of the latter has arisen by the squamosal of the reptile usurping the functions of the quadrate. But here lies a difficulty other than

that presented on a preceding page. If this assumption be true, the articular head of the mammalian lower jaw should represent the articulare, while between this and the tip of the jaw, several bones — angulare, splenial, dentary — should occur. In fact, the lower jaw in every mammal, so far as known, ossifies as a single membrane bone, which we prefer to regard, until better evidence is forthcoming, as the dentary of the lower vertebrates. The articulare we recognize in the body of the malleus, while since a new fulcrum of the lower jaw has been formed, the other bones, angulare, supra-angulare, splenial, etc., having no longer cause for existence, have disappeared without leaving a trace behind. Their proper position would be around that portion of Meckel's cartilage which for a while persists between the malleus and the osseous lower jaw.

In examining the shape, relations, etc., of the manubrium, which, as was noticed above, arises separately from the rest of the malleus, one can hardly fail to be struck with its resemblance to a somewhat reduced visceral arch. This resemblance is the more interesting since the cartilage appears in the very place where, according to several students of the problem of the segmentation of the vertebrate head (Dohrn, van Wijhe, Beard, Locy, Neal, etc.), a segment has apparently almost entirely disappeared from the vertebrate head. Whether this and the distal cartilage of the reptilian columella be the visceral arch of the missing segment, and whether the Eustachian tube really represents two confluent gill slits, we do not at present care to discuss.

DESMOGNATHUS FUSCA (RAFINESQUE) AND SPELERPES BILINEATUS (GREEN).

HARRIS H. WILDER.

As the two species which form the subject of this paper are widely distributed over the United States, it is probable that the differences in environment in the different regions may cause them to vary somewhat in their mode of life. The observations recorded here are confined to the Counties of Berkshire, Franklin, Hampshire, and Worcester, in the state of Massachusetts, and the statements made concerning their frequency, manner and times of occurrence, etc., are primarily applicable to this region. It will also be noticed that the authors quoted, with the exceptions of BAIRD and COPE, have in mind a restricted locality in each case (Massachusetts, Maine, New York) not far from the region in which these observations were made.

The object of this paper is to render available for laboratory purposes, and especially for the study of histology, two of our abundant native salamanders, which have hitherto been too much neglected, both because they are not easily found without a little experience and because they are apt to be confused with each other, especially during their larval life. The ease with which European investigators may obtain and identify their one classical species, *Salamandra maculosa*, without needing to be experts in systematic literature, or running the risk of erroneous conclusions by confusing externally similar species, is often envied here in America, where our very wealth in Urodelan material is a frequent source of vexation to the investigator, who realizes that even in histological research he cannot afford to be mistaken in the species studied. The two species considered here present many advantages which should make them favorite animals for laboratory research, when the

difficulties of finding them and distinguishing them from each other are once removed.

Early Reports of their Occurrence. — The earlier writers on the subject seem to have considered both species very rare, a circumstance which must be attributed wholly to their habit of concealment and the difficulty of finding them to one not familiar with their ways. They are evidently indigenous species, and we cannot here have to do with a recent increase in numbers, as in the case of the English sparrow or the periwinkle (*Littorina*). The first of these two salamanders to be discovered was *Desmognathus fusca*, first described by RAFINESQUE ('20) as *Triturus fuscus*, described later by HARLAN ('22) under the name of *Salamandra picta*, and cited as such by STORER ('37) in his "Report."

STORER states that he has never met with this species himself, but includes it in the list of Massachusetts Amphibia on the authority of Dr. PICKERING, who had seen one specimen that was found in a well in Ipswich, Mass.

DEKAY ('43) includes this species among the fauna of the state of New York, on the ground that it has been found both in Massachusetts and in Pennsylvania. The other associated species, *Spelerpes bilineatus*, does not appear to have been reported by any of the above authors, and was first described by GREEN ('18), who found it in New Jersey and named it *Salamandra bilineata*. It is thus clear that the two species in question, in spite of their abundance, were considered rare by the earlier authors.

Of especial interest to me has been a more recent report, by J. A. ALLEN ('68), on the Amphibia "found in the vicinity of Springfield, Mass.," in which he adds, after the name *Spelerpes bilineatus*, "one specimen, rare."

The next name on the list is that of *Desmognathus fusca*, which he has not found at all, but quotes it as having been found in the state. He writes that this species is "equally rare with the preceding" (*i.e.*, *S. bilineatus*). This failure to find these two commonest species is the more singular since the author proves himself a careful collector by including in his list such species as *Pseudotriton salmoneus* and *Plethodon gluti-*

nosus, which are rarely met with in this locality. It cannot be said, however, that all authors are in accord concerning the rarity of these two salamanders. It is noticeable that BAIRD ('50) and COPE ('89), both of whom had exceptional opportunity to study specimens from an extensive area, do not consider it rare. COPE ('89) distinctly states, on the other hand, that *D. fusca* is "perhaps the most abundant salamander in N. America."

Habitat. — Both of the salamanders in question are similar in habit and are commonly found associated. Although both are very common, they are so skilfully concealed, at least by day, that special knowledge is necessary in order to collect them in abundance. This is doubtless the reason why they have been considered rare.

They are found in and about running brooks that are plentifully supplied with small stones, and they seem to prefer spots shaded by trees. Perhaps the best brooks of all are the little mountain streams that run swiftly down quite steep inclines, forming miniature cascades alternating with small shallow basins. Mountainous regions abound in such brooks, which may be usually located from a distance by noting the places where the slopes of two hills converge, forming a ravine. When such a brook is found, begin the search by turning over all the stones and bits of fallen logs that lie in the immediate vicinity of the edge of the brook. Stones, lying a foot or more above the water and upon the dry bank, will yield nothing, and, on the other hand, stones nearly or wholly submerged in the flowing water will be profitless, since any animals contained beneath them may easily escape by slipping along with the turbid current. The best stones are rather irregular ones, lying on the edge of the brook, and with the bottom surface just below the level of the water. The right sort of a stone, when lifted, should reveal a shallow cavity formed in the wet sand or mud, but containing little or no water at the moment at which the stone is removed.

A little experience will enable the seeker to determine just which stones or other objects lie in the right position to serve as protection for the salamanders, and thus the labor becomes

much lessened. Since the adult salamanders are extremely slippery and often very rapid in their movements, it is advantageous to keep in one hand a small net of cheese cloth, having an aperture about six inches across, and with a very short handle.

The larvæ of both species are to be sought for in the water, and may be seen lying upon the bottom of the quiet pools, especially those with a fine gravel bottom. Even at this stage they are fond of concealment, and if there are small stones, fallen leaves, or other objects in these miniature basins, they should be removed and the water allowed to settle. The larvæ may be easily captured by means of the net. This should be laid upon the bottom and the larva driven into it by approaching it from behind with the hand or a small stick. The great majority of the larvæ collected in this way are those of *Spelerpes*, as it remains much longer in the larval state, but the very similar larvæ of *Desmognathus* occur in similar places and are very difficult to distinguish from the others. (See below.)

Adults. — As the two species belong to different subfamilies, it would seem an easy matter to distinguish the adults, but unfortunately the most distinctive characters are skeletal, and the external feature, such as color, number of costal folds, etc., although noticeably different in extreme or typical specimens, show so many gradations and intermediate forms that the determination is in many cases extremely difficult. Both species are dark above, marbled along the sides, and without pigment ventrally. Both species possess a broad dorsal stripe with crenulate edges. This stripe in typical specimen of *D. fusca* is very dark brown, so that in living specimens it merges almost indistinguishably into the dark slate color which limits it laterally. In the other species the dorsal stripe is usually light brown or fawn color, lighter at its outer edges and bordered by a very dark brown stripe, hence "*bilineatus*." It is, however, quite usual to find specimens of *D. fusca* with a light rufous dorsal band, set off very conspicuously from the slate-color at its outer edges ; while in many specimens of *S. bilineatus* the dorsal band is quite dark, without lighter edges, thus blending

into the dark lateral line which in time becomes lost in the dark color of the flanks, the result being similar to that seen in the lighter specimens of *D. fusca.* The ventral side furnishes a surer test, as it is usually of a light lemon yellow color in *S. bilineatus* and white and semi-transparent in *D. fusca.*

This yellow color of the former species changes to a light salmon pink in specimens thrown alive into aqueous corrosive sublimate. As for general shape and size, *D. fusca* attains a greater size, and in these large specimens (10 cm. +) the large muscles of the jaw form definite protuberances upon the head. *S. bilineatus* is not as robust a species as the other, and the tail particularly seems more slender and longer in proportion. The number of costal folds may often be useful as a diagnostic, but this character seems liable to individual variation, and one is always in doubt where to place the beginning and end of the series counted. In *D. fusca* there are generally twelve folds (*i.e.*, the myotomes, not the myocommata) between the fore and hind limb, while *S. bilineatus* shows usually fourteen or fifteen. These numbers can, however, be used for comparison only in a general way, for the relative position between these folds and the place of origin for the limbs appears to be subject to variation. Perhaps the surest method of distinguishing is to collect a few typical specimens of each, and use them as standards for comparison, employing the other diagnostic points as they may seem applicable in individual cases.

Eggs. — The eggs of *S. bilineatus* appear to be the more common, or at least the more usually found, and may be obtained during May and June. I have found them at the following dates: May 27, June 12. They are deposited in a single layer upon the lower side of submerged stones, each batch containing from 30–50 eggs. The stones which are suitable for this purpose must be in the form of an arch allowing the water to flow beneath, as in the diagram, Fig. 1. They are generally in the more rapidly flowing portions of the brook, but the depth of water must be such that the eggs are at all times entirely submerged, as the dash of the surface ripples striking against them would subject them to mechanical injury.

The eggs appear attached to the surface of the stone by gelatinous threads proceeding from the outer envelope, and although they are generally contiguous, they are each attached separately. Within the eggs the embryos lie free, the heavier

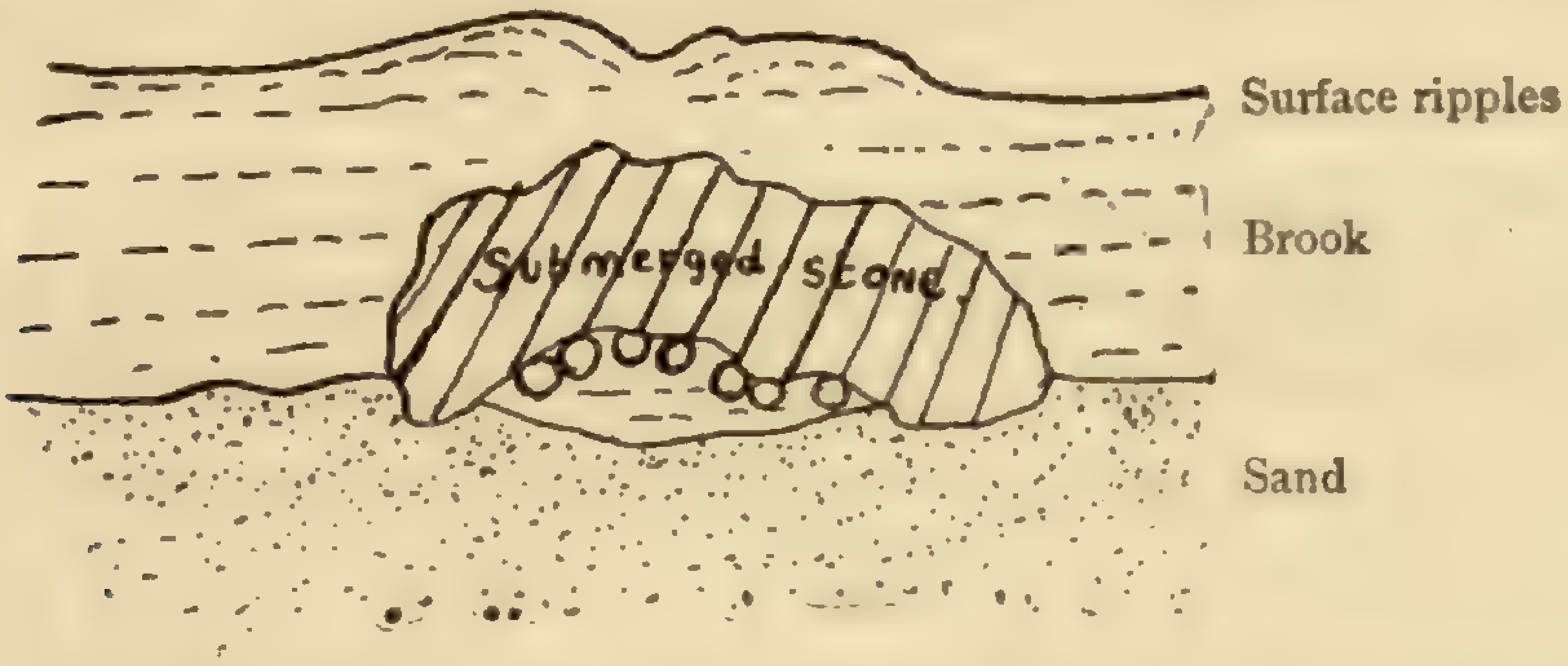


Fig. 1. — Diagram showing method of deposition of eggs employed by *Spelerpes bilineatus*.

yolk being always beneath. When the normal position is changed by the sudden overturning of the stone, the eggs roll over simultaneously in order to resume their normal position.

The eggs and their manner of deposition have been well described by Verrill ('62, '63), although the author considers

Fig. 2. — *Desmognathus fusca* ♀ with egg-rosary. Natural size.

them as the eggs of *Desmognathus fusca* and describes them under that name.

The eggs which really belong to this latter species, as described by Baird ('50) and later by Cope ('89), are laid in a long string and wrapped around the body of the female like a rosary. Cope's statement is as follows: "Professor Baird originally noticed the curious disposition of the eggs in this species,

which I have verified on a few occasions. As in the Anurous genus *Alytes*, the eggs, on emission, are connected by an albuminous thread, which soon contracts and hardens. One of the sexes protects this rosary by wrapping it several times round the body and remaining concealed in a comparatively dry spot. How long this guard continues is not known." (Cope, '89, pp. 196, 197.)

After searching for such eggs during several seasons in vain, I was able finally to confirm these statements by means of a batch of eggs which were laid in my laboratory *terrarium*. When found (June 1, 1898), the position of the mother and

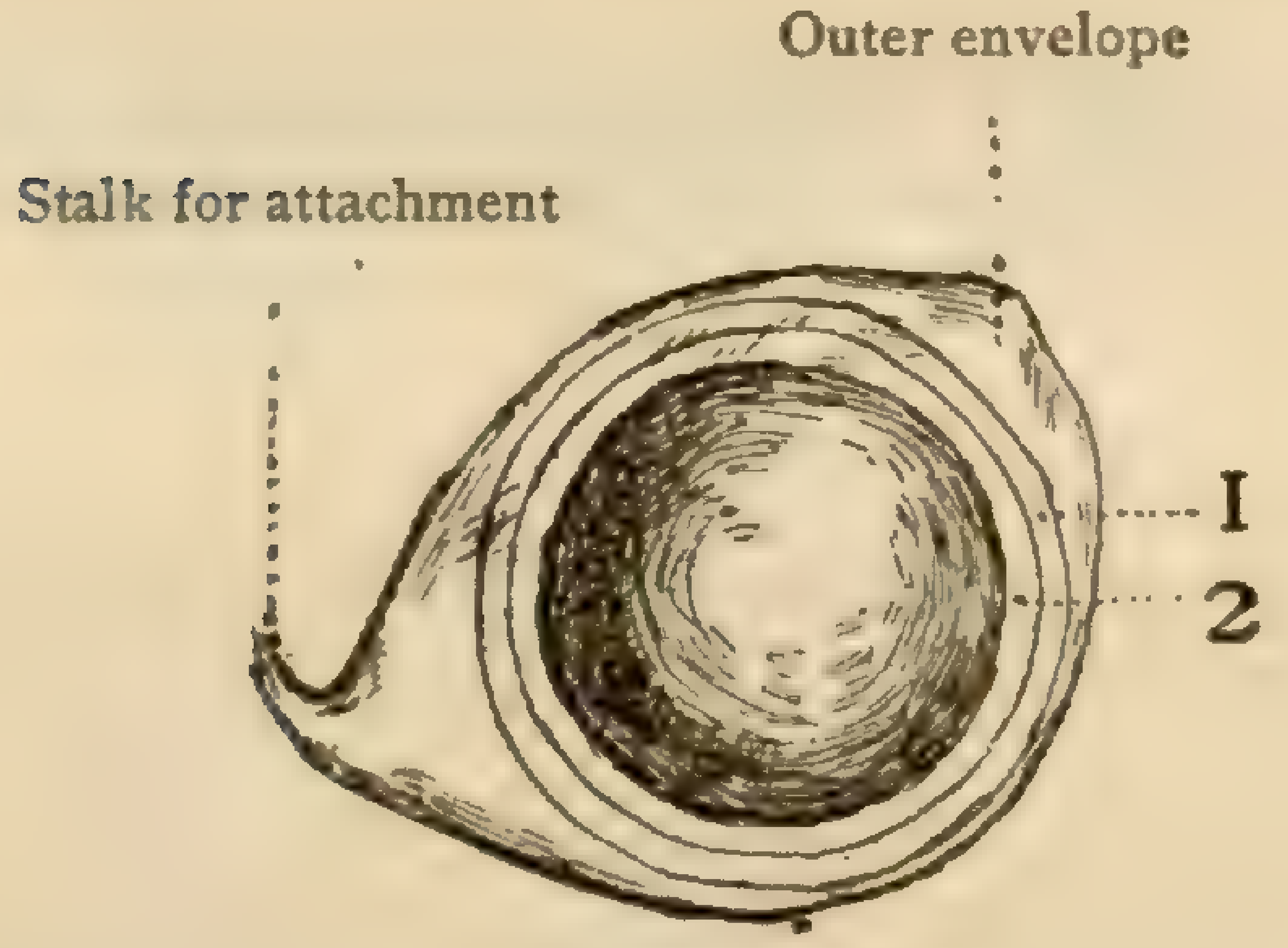


Fig. 3.

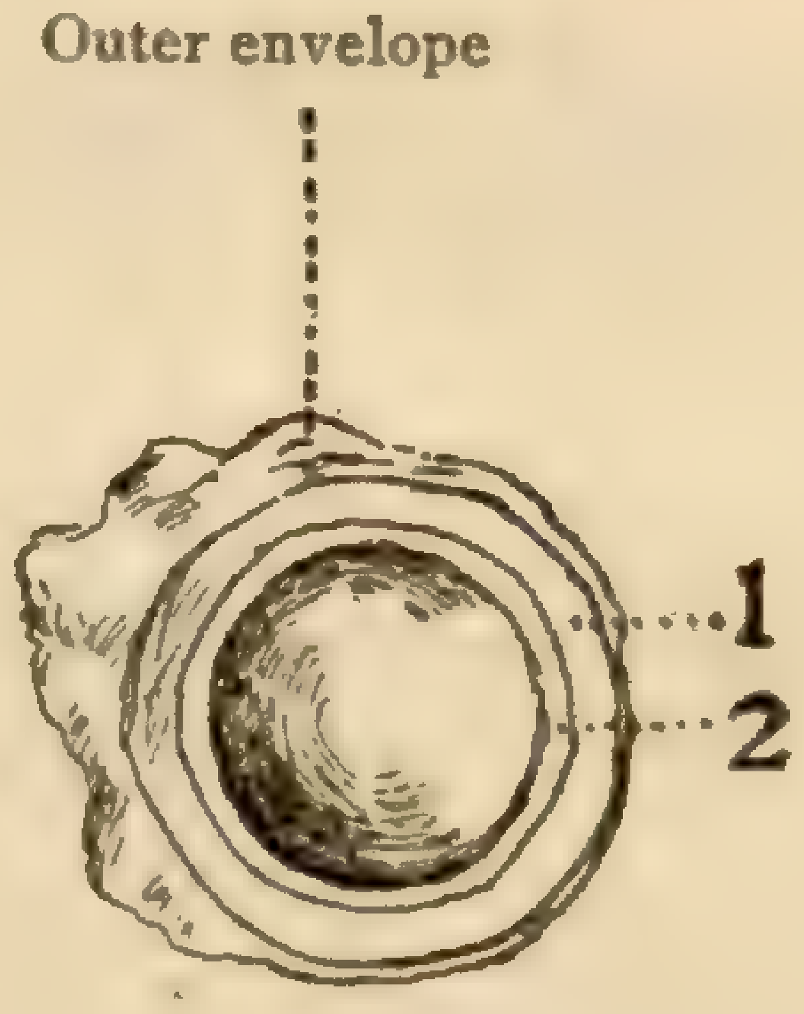


Fig. 4.

Fig. 3. — Egg of *Desmognathus fusca.* × 5.
Fig. 4. — Egg of *Spelerpes bilineatus.* × 5.

eggs was as represented in Fig. 2, which is drawn as though looked directly down upon from above.

The adult lay beneath a brick and in an irregularly oval hollow made in the mud, evidently by herself.

The eggs, which showed then no signs of development, and which must have been just laid, were, indeed, wrapped about the body of the parent, but not in a definite single string. Each was surrounded by a loose outer membrane which tapered a tone end to a strong cord, and several or all of these cords seemed to focus at a single point, much like a bunch of toy balloons held in the hand of a street vender. The attachment to the body was loose, and was evidently effected by the female by winding her body in among the strings. The eggs changed their position somewhat from day to day, as though, by the movement of the parent, new combinations had been

produced. It is even possible, in consideration of the marked nocturnal habits of this species, that the female may leave the egg-mass during the night, returning to it by day.

Comparison of the Eggs. — The comparative size of the eggs of the two species is shown in Figs. 3 and 4, in which they are drawn five times the natural size. Each appears protected by three membranes, two that fit closely and an outer loose one. It is by means of strings proceeding from this latter that the one is attached to the parent and the other to the surface of the stone, although in the latter case there appears to be a definite adhesion, in which not only the stringy processes but also the surface of the membrane itself participates. As the development shows, the egg of *Spelerpes* is holoblastic, like the more usual amphibian egg, while that of *Desmognathus* is meroblastic.

Development of Spelerpes. — Figs. 5–19 represent a series of views illustrative of the external development of *Spelerpes* and drawn to the same scale (× 5). As the eggs used in these observations were of several different ages, it was not easy for me to fix definite time-limits to the several stages.

The oldest eggs collected were almost at *Stage d* when found. *Stages a–d* rest upon observations made upon the youngest lot collected ; *e–h* are consecutive stages of the oldest lot. As I have the dates of the stages figured, the record is complete, except for the time between *d–e*, which may be from 24–48 hours. The record, compiled from my notes, is as follows :—

Stages a and b. The youngest eggs collected May 27, at 10 A.M., showed no visible traces of external folds. Their appearance 24 hours afterward (10 A.M., May 28) is represented in Figs. 5–9. The development was somewhat uneven, and *Stages a* and *b* were selected as the extremes.

Stage c. These were drawn from the same lot as *a* and *b*, six hours afterward, May 28, 4.10 P.M. (Figs. 10, 11.)

Stage d. Killed May 29, 12.20 M. (Figs. 12, 13.)

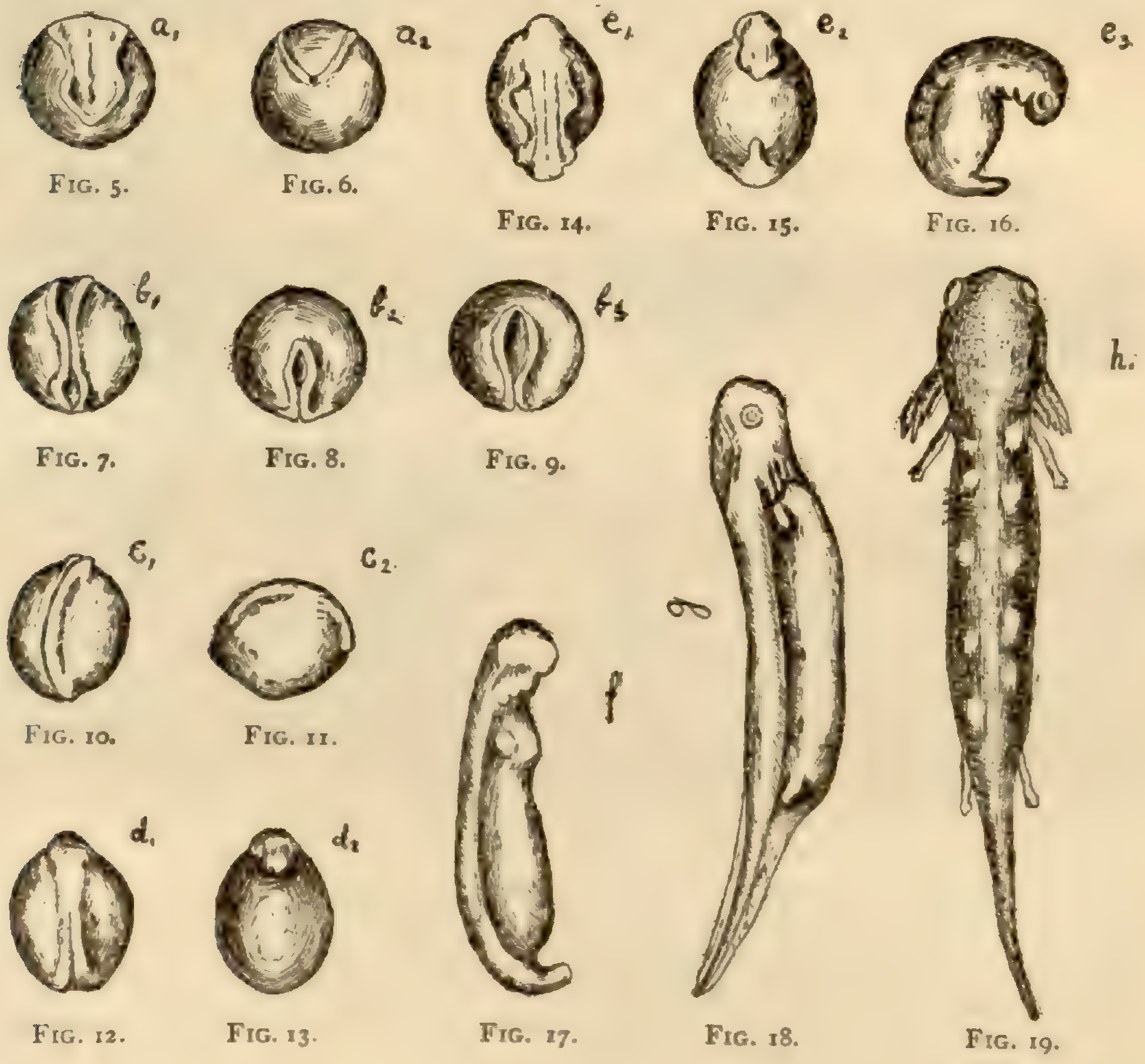
Stage e. These are from another and more advanced batch of eggs. All the other stages are taken from this lot.

The specimens of *Stage e*, as figured here (Figs. 14–16), were killed May 28, 4 P.M. The time it takes *Stage d* to reach the

development shown by *e*, I cannot tell, but suppose it to be 24–48 hours.

Stage f, June 1. (Fig. 17.) Embryos move in eggs when disturbed.

Stage g, June 6. (Fig. 18.) For this stage I have the following memorandum: "When taken out of egg membranes, swim about in watch crystal very vigorously for a few seconds and



Figs. 5–19. — Developmental Stages of *Spelerpes bilineatus*.

repeat this each time when touched. Dorsal surfaces show pigment, light grayish appearance. Under lens, minutely mottled with pale gray dots (pigment cells), 6–7 little squarish areas left unpigmented in double row along back. These are to be the characteristic light spots of the larvæ." 5–7 days after reaching this stage the larvæ hatched. In the first case observed, June 11, the eggs broke when extracted from the water and liberated the larvæ. A note as follows: "It had to be *caught* with the little net; it swam about rapidly from one

side of the tank to the other and *avoided* the net. Could not be caught with a watch crystal. Movement, avoiding the net, etc., as in older larvæ." On June 13 the rest hatched.

Stage h. (Fig. 19.) Killed June 16, three days after hatching, 12.5 mm. long.

Development of Desmognathus. — Although I have fewer stages here to record, I can be more certain with the time-ratios between the stages, since all the observations were made upon a single batch of eggs, the ones described above, found

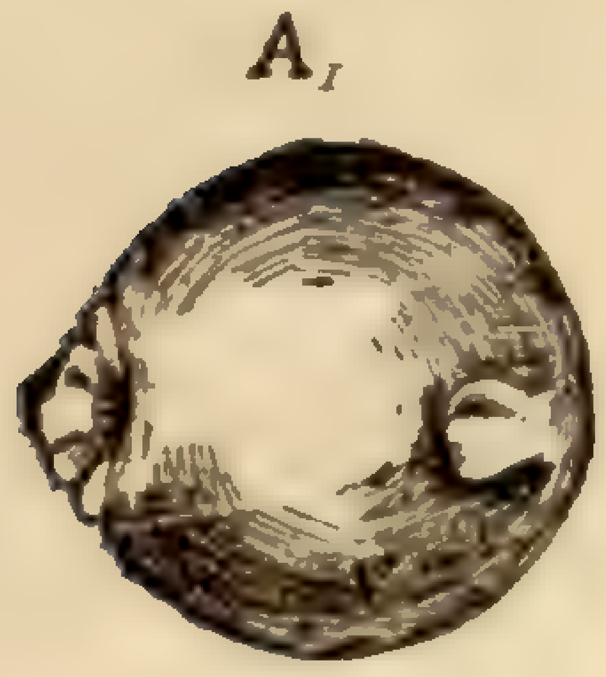


FIG. 20.

FIG. 22.

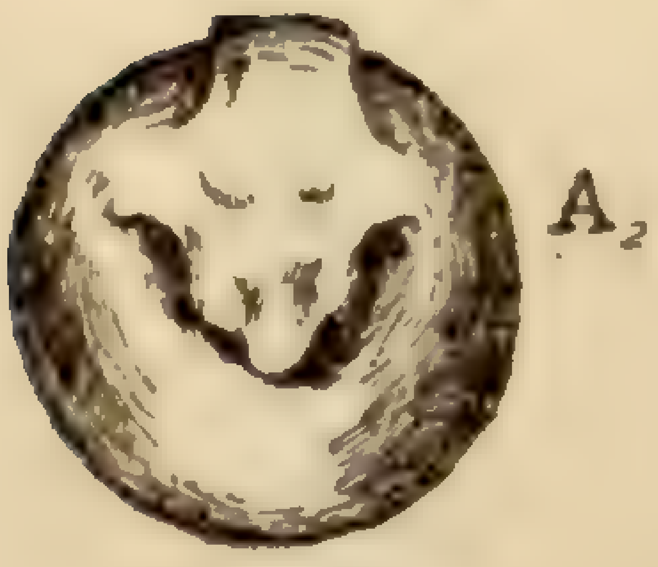


FIG. 21.

FIG. 23.

FIG. 24.

FIG. 25.

FIGS. 20–25. — Developmental stages of *Desmognathus fusca*. In the above series the stages are represented by letters, small letters for *Spelerpes* and capitals for *Desmognathus*. The stages in the two series do not correspond. Different views of the same stage are designated by numbers attached to the letter. *All the figures are magnified five times.*

June 1, and probably laid the night or the day previous. My observations cover but four stages, as figured here, and the dates of the stages are as follows:

Stage A (Figs. 20–22), June 11.
Stage B (Fig. 23), June 14.
Stage C (Fig. 24), June 18.
Stage D (Fig. 25), June 21.

The pigmentation which was distinctly noticeable in *Stage C* had by June 24 distributed itself in the characteristic pattern, leaving little unpigmented squares in the manner described for *Spelerpes*. I killed the last embryo June 30, at which date the

specimen, although still in the egg, and leaving a large yolk-sac, was in other respects a fully developed larva. The pigmentation was complete, the external gills fully developed, and the feet had the full number of distinct toes (4 anteriorly, 5 posteriorly).

Larvæ of Desmognathus fusca. — From the suggestions of the previous paragraph, it becomes probable that the larva of *Desmognathus* remains in the egg until very well developed. My oldest embryo, taken from the egg June 30, is 13 mm. in length, still possessing so large a yolk-mass that it was evidently intended to remain in the egg for a much longer time.

I have taken *Desmognathus* larvæ only during the months of August–October, and these vary from 20–30 mm. in length, with external gills much reduced.

During fall and early winter the smallest adults are found 35–40 mm. in length, and differing from the largest larvæ mainly in the absence of the external gills.

Summing up the evidence, it becomes probable that the larvæ of *Desmognathus* remain in the egg until nearly adult, that they emerge from the egg in midsummer, that the gills, smaller at the time of hatching than at an earlier embryonic period, become gradually lost — a process which becomes complete during the late fall of the same year in which the eggs are laid. This history will readily explain the fact why the larval *Desmognathus*, perhaps the commoner of the two species considered, is so rarely met with. I have collected many hundreds of the larvæ of *S. bilineatus*, and a very few, not more than twenty in all, of the larvæ of *D. fusca*. In habits these larvæ resemble the adults. They avoid the deeper pools which abound in the larvæ of the other species, and lie where it is very shallow or in the wet sand, where they may find in places just water enough to cover them. When alarmed they run rather than swim, often abandoning the water, running with a series of quick jumps over the wet sand. Cope's only mention of this larva is so short and couched in such general words as to be applicable to either species. He says: "Its delicate larva may be observed darting rapidly from place to place, seeking concealment among mud and leaves." The color and marking

of this larva, as before mentioned, are identical with those of the larva of *S. bilineatus*, and are thus useless as a distinguishing test.

Larvæ of Spelerpes bilineatus. — The larvæ of *S. bilineatus* hatch early and continue for a long time in the larval state, probably 2–3 years.

COPE ('**89**) says: "It is one of those species whose metamorphoses are prolonged and which remains in the larval state until nearly grown." VERRILL ('**62**, '**63**) says of it, under the name of *D. fusca:* "The young become quite large before losing their gills." This description cannot apply to the genuine *D. fusca*, as has just been shown, and as the author has described in the same paper the eggs of *S. bilineatus*, the larvæ he found undoubtedly belonged to this latter species, concerning which the statement is an accurate one. The growth must be exceedingly slow and dependent upon the fortune of the individual in securing prey. I have caught all stages from 16–52 mm. at all seasons of the year, and see no indication that those larvæ collected at any one time represent one, two, or three years of definite growth.

For the purpose of studying this point I went to Williamstown, Mass., in September, 1896, collected 90 larvæ, and measured and tabulated each.[1] The result of this is shown graphically in Fig. 26, in which the ordinates represent the total lengths in millimeters, and the abscissas the number found. The results seem to show, in general, merely a decrease in numbers as the animal gets larger, which was to be expected.

There are gaps in one or two places, indicating sizes that I did not find, but these are by no means wide enough to represent a year's growth. 52 mm. represents about the limit of size reached by the larvæ under the most favorable circumstances. I have found adults a little smaller than this.

Differentiation of the Larvæ. — The fact that the larvæ of *S. bilineatus* are exceedingly common, while those of *D. fusca* are rare, renders it *a priori* probable that a given larva belongs

[1] I was materially assisted in the collection of these larvæ by my good friend, the late Dr. James I. Peck, whose kindness I most pleasantly remember in this connection.

to the former species. This may become a certainty if the larva be above 35 mm. in total length. At about 20 mm. the larvæ of *D. fusca* have very small external gills, and the tail fin is obsolescent; while larvæ of *S. bilineatus* of the same size have very apparent external gills and a very broad tail fin, ending obtusely. In general, the larva of *D. fusca* is at all stages suggestive of maturity, while that of *S. bilineatus* is larval and piscine in its general appearance. The former resembles *Amblystoma* in shape, the latter *Necturus*. The former has a

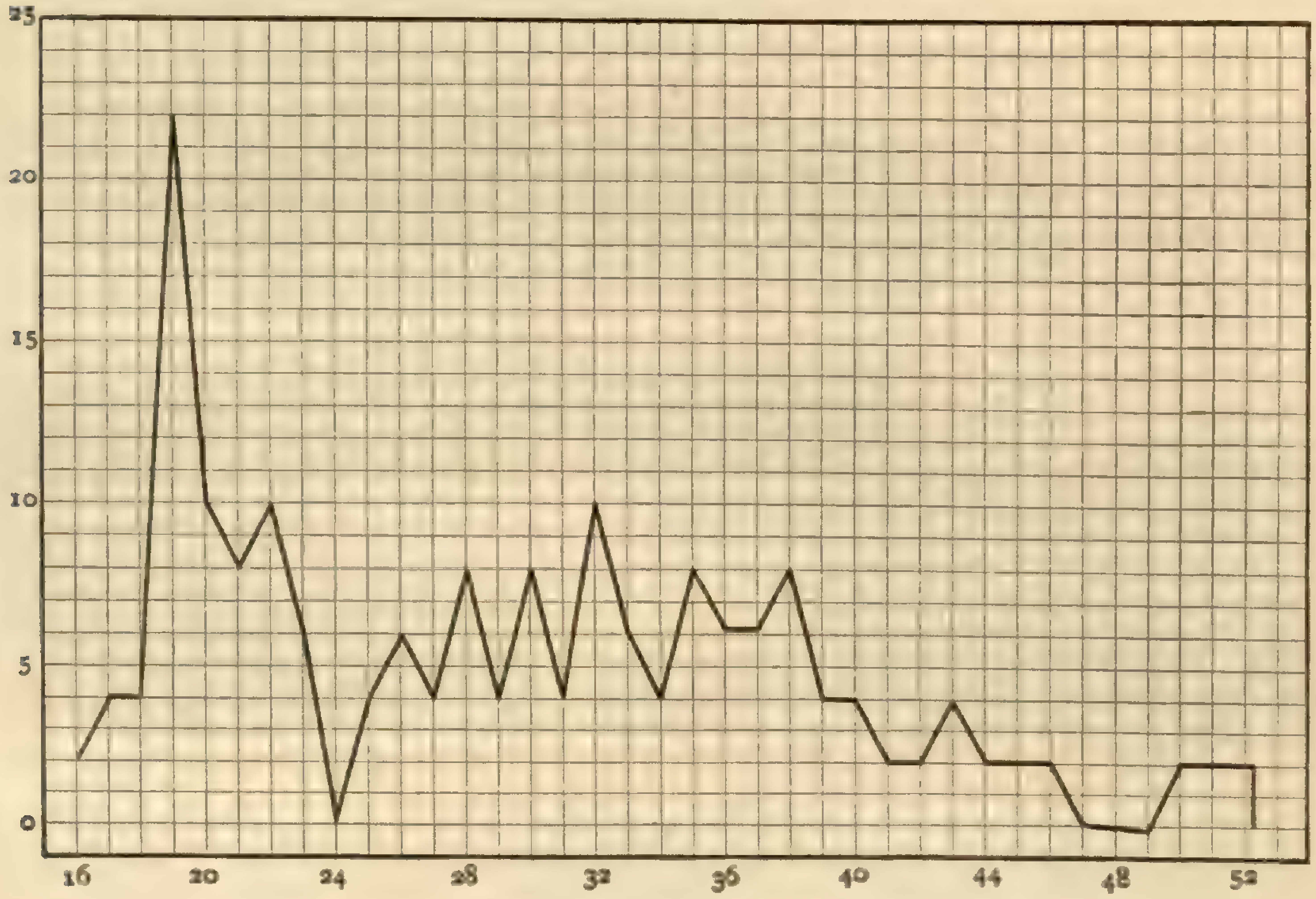


FIG. 26. — Curve showing frequency of the larva of *S. bilineatus* at its different stages.

short head, rounded above, shows well-marked costal folds, has robust limbs and a narrow tail fin. The latter has a long flat head, obscure costal folds, and a very broad tail fin. A definite distinguishing characteristic does not seem to exist, but there are so many general distinctions that a person who has once studied and compared the two will find no difficulty in identifying each species at any stage.

Method of Rearing in Confinement. — The adults of both species, because of their peculiarities in respiration and the consequent necessity of keeping their skin moist, cannot be kept either in water or in a dry atmosphere, but may easily

be kept for months or years in an ordinary fernery where the atmosphere is constantly saturated with moisture. I have in my laboratory a large fernery or *terrarium*, about 2 × 3 feet square and 2 feet high. The bottom consists of a zinc tray, 8 inches deep and water-tight. The top and sides are of glass and the front side runs in a frame with weights, being thus capable of being raised and lowered like an ordinary window-sash. In the bottom of this there are about 6 inches of good garden soil, in which are planted ferns and other wood plants. The surface is partly covered with moss, and here and there are placed several stones, the size of one's fist, and a few pieces of rotten stump, arranged so as to give shelter to the adults. In one corner a crystallizing dish is sunk to the level of the soil. This is filled with water and the bottom covered with a little fine sand. Some duckweed, or Salvinia, may be placed upon the surface, and a few small stones should be put in a dish. At the beginning of the season, after arranging everything as above, enough water is poured in to drench the soil, and the sunken dish is filled. After this the *terrarium* is self-regulating. The water that evaporates is re-precipitated as moisture, and the total loss from the little pond in the corner is so slight that it needs replenishing not oftener than once in six months. If the *terrarium* is to support many animals, it is better to place a few earthworms, myriapods, etc., in it; and if the pond is designed for the rearing of larvæ, supplies of Entomostraca and a little Spirogyra to feed them with should be occasionally introduced. I have tried placing tiny bits of meat in prominent places, but they merely mould and have to be removed. I have kept as many as 20–30 adults and a dozen larvæ in my *terrarium* during an entire college year, and several times, on clearing it out in the fall after the summer vacation, I have found alive and in good condition adults which I had been unable to find in the spring, when I intend always to remove the animals. It seems most probable that these salamanders find enough to eat among the worms and insects introduced with the earth and plants, as they always appear in perfectly normal condition and contrast very forcibly with *Diemyotylus*, which grows thin and often starves to death when placed under

the same conditions. An examination of stomachs would, of course, settle this point; but I do not happen to have on hand at present any specimens which are known to have been kept for a long time in this manner.

Advantages as Laboratory Animals. — The advantage suggested in the previous paragraph is an important one, being animals that may be *easily kept in the laboratory during the winter without feeding or other attention.* To collect them from the *terrarium*, lift up the stones exactly as when in the field, or else wait until 9 or 10 P.M., and bring a light suddenly upon them. They are nocturnal and at such times forsake their concealment and crawl about over the glass sides and roof.

A second great advantage is that they *may be collected out of doors all the year round, except during the time of deep snow.* I have collected them with ease here in December and in March, thus leaving an interval of not more than 8–10 weeks during which they cannot readily be obtained. The eggs are peculiarly adapted to all sorts of experimentation; they lack the black pigment of the frog's egg, and thus give better results in staining. As their development is later in the year, they may be obtained after the eggs of frogs and toads have disappeared. The eggs of *S. bilineatus* develop readily when removed from the rock on which they are laid, if they are placed upon sand in a dish of water into which fresh water is constantly being introduced through a small pipe or glass tube. Those of *D. fusca* develop in the *terrarium*, and may be removed singly from the mass without disturbing the parent. It is highly probable that a mass of *Desmognathus* eggs would develop equally well when removed from the parent, if kept in the *terrarium* under the usual conditions; but I have not yet had an opportunity to test this, and it is at least possible that necessary moisture and even warmth may be derived from the body of parent.

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THE POISONS GIVEN OFF BY PARASITIC WORMS IN MAN AND ANIMALS.

G. H. F. NUTTALL.

MANY of the symptoms affecting the human subject as well as animals who harbor parasitic worms have been attributed by certain authors to poisons which the latter develop within the body of their host. Peiper, of Greifswald, recently published an article in which he gathered together a good deal of evidence from scattered sources, evidence which very clearly proves that a number of worms do give off poisons.

In the case of the Ascari (familiarly called round or maw worms), which are found in man, the pig, the cat, and horse, the evidence is very striking. There are a number of cases recorded where children who suffered from convulsions, loss of consciousness, great loss of flesh, anæmia, and other symptoms, were promptly and permanently cured of all of these by the use of medicines ("anthelmintics," vulgarly called "worm medicines"), which removed the parasites from the body. A number of authors have claimed that these parasites were simply injurious through their presence as foreign bodies within the intestine, as well as through their boring, their active movements, and their robbing their host of his proper share of the food he had eaten. That these worms contain some poisonous substance was claimed by Miram, who whilst studying the *Ascaris megalocephala* suffered twice from attacks of sneezing, swelling of the eyelids, and excessive secretion of tears, besides severe itching and swelling of the fingers which had been in contact with the worms. Von Linstow noted that when these worms were cut open they gave off a sharp, peppery odor and caused tears to flow from his eyes. Inadvertently touching his eye with a finger which had been in contact with these worms, a very severe inflammation of the conjunctiva, with a condition known as chemosis, resulted. Raillet, Arthus,

and Chanson had similar experiences. The latter two observers, working with an ascaris from the horse, suffered in addition from pain in the throat and loss of voice. These experimenters found that two cubic centimeters of the fluid taken from the inside of these worms would kill a rabbit.

Kolbe, of Reinez, after having read Peiper's publication, above referred to, reported a remarkable case of a child he had unsuccessfully treated with the regular worm medicines. The boy had suffered for over a year from severe abdominal pains, frequent attacks of fainting, and convulsions. The doctor having been unsuccessful, a friend of the boy's mother — a baker by trade — suggested that she should rub up a dried roundworm with sugar, and make the boy take it. This "homœopathic" remedy had an immediate effect; two tangled masses of worms the size of a fist being given off by the patient, who made a prompt and complete recovery. Cobbold and Davaine have reported cases where various nervous symptoms had subsided on the removal of tapeworms. Marx saw an epilepsy of three years' standing cease on the removal of a *Tænia solium*. It is curious that the eyes are so frequently affected in those suffering from tapeworms. It is quite possible that this is due to the effects of a poison circulating in the blood, the same having been absorbed from the intestine where the parasite is domiciled. In five out of fourteen cases of patients harboring the tapeworm known as *Tænia nana*, Grassi observed serious symptoms resembling those of epilepsy.

Another worm, the Bothriocephalus, may cause severe anæmia, which has variously been explained as due to a peculiar poison, to effects resulting from the *death* of the worm, or to the length of time that the individual has harbored the parasite. A blood-sucking worm, the Anchylostoma, which may occur in hundreds and even thousands in the intestine, was believed by Lussana to contain a poison, and not to injure its host simply through the loss of blood it entailed. Looss, of Cairo, also states his belief, in a recent publication, that these parasites contain a poison. Working with the larvæ of this worm last summer, he found that even after carefully washing them, they caused dogs which had swallowed them to vomit, whereas the

water in which the parasites had been washed had no effect on the dogs.

The *Tænia ecchinococcus*, a tapeworm which in one form of its parasitic life gives rise to the condition called "Hydatid cyst," also gives off a poison, for the fluid taken from the cyst has been shown to be toxic by Debove and Humphrey, who experimented on men and animals. This explains the severe symptoms and even death which may follow the puncture of a cyst by the surgeon, or its spontaneous rupture. There is also reason to believe that the Trichina and other parasitic worms give off poisons. At any rate, we have a fruitful field of investigation open to research along these lines, and there may be a good deal in the home remedy of the baker worm-specialist!

HYGIENIC INSTITUTE UNIVERSITY OF BERLIN.

A CURIOUS MALFORMATION OF THE SHIELDS ON A SNAKE'S HEAD.

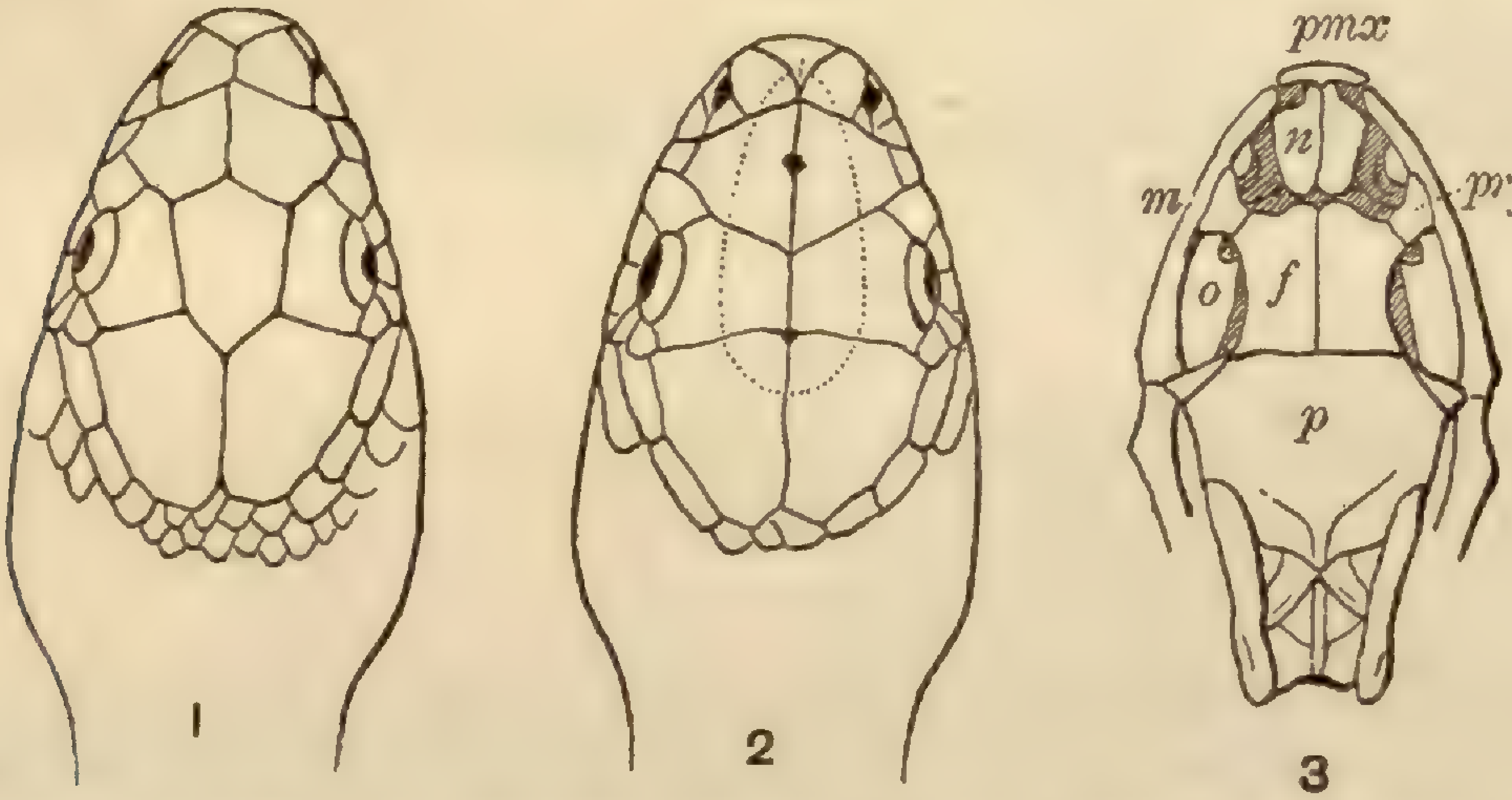
LEONHARD STEJNEGER.

Dr. Josua Lindahl, director of the Museum of the Cincinnati Society of Natural History, recently sent me a snake for examination which had defied all attempts at identification on account of the extraordinary scutellation of the top of the head. It was an old specimen found in the basement without label and without indication of origin or locality. Its color is entirely faded out, the snake is extremely emaciated, and the preservation of the body is bad. However, I think I make out 25 scale-rows, 229 ventrals, a double anal, and about 80 caudals; Lindahl's measurements are: length, 53 inches; tail, 8¾ inches.

The principal feature of the top of the head is the total absence of an unpaired frontal, the meeting of the supraoculars in a broad suture on the median line, and the extraordinary size and shape of the prefrontals. In the suture between the latter there is a deep pit filled up with soft skin, and the rostral shows some signs of damage by violence. These features and the general extraordinary aspect of the top of the head are shown in the accompanying sketch (Fig. 2). In all other respects the snake appeared to be normal, and while the above-mentioned features looked outlandish enough I was soon convinced that I had only to do with a most abnormal specimen of the typical colubrine snakes. An examination of the dentition and other structural characters showed that the specimen belonged to the genus commonly known as *Coluber*, while the more minute details of the scale formula, *viz.*, one preocular, two postocular, two large anterior temporals, in addition to those given above, pointed directly to *Coluber obsoletus*, the common "mountain black snake" of the eastern and Austroriparian faunas of North America. A direct comparison with specimens of this species confirmed the correctness of the identification. For the sake

of illustration I add a sketch of the upper surface of the head of a normal specimen (Fig. 1).

In considering the cause of this malformation I was attracted by the pit in the inter-prefrontal suture, and it at once struck me that it was located in the fontanelle, between the nasals and the frontal bones. The meeting point of the inter-supraocular suture with that of the inter-parietal suture also shows soft skin. The median suture between this point and the pit corresponds to the suture between the frontal bones. A sketch of the top of the skull of the species is added (Fig. 3) to make



Diagrams of top of head of *Coluber obsoletus*. Fig. 1. — Normal specimen. Fig. 2. — Malformed specimen. Fig. 3. — Top of skull: *f*, frontal bone; *m*, maxillary; *n*, nasal; *o*, orbit; *p*, parietal; *pmx*, premaxillary; *pxf*, prefrontal.

these points clear. Knowing the regenerative power of the reptilian tissues, I could not escape the impression that the true explanation of the malformation is an injury to the skin of the top of the head, by which the whole derm from the rostral to beyond the posterior end of the frontal became removed. In healing, the covering of the wound probably started from the edges of the lacerated adjoining scutes, which continued to grow until they met on the mesial line. In the sketch (Fig. 2) I have indicated by a dotted line the probable extent of the injury, but I am bound to add that there is no indication in the specimen. It must be remembered that the epidermal covering is regularly shed, and that the outline of the wound which probably was visible in the first covering may have disappeared in the succeeding molts.

EDITORIAL.

The Society of Morphologists, at its recent meeting in New York, voted that the *American Naturalist* should be the official organ of the society. The Society of Morphologists is one of the most energetic of the societies affiliated with the Society of Naturalists, and includes a large proportion of the active workers in zoology east of the Rocky Mountains.

We are therefore very glad to accept the vote of the Society of Morphologists, and to place our pages at the disposal of the officers of the society for notices and of other members for communications on matters relating to the society. We shall be glad especially to receive papers read at the meeting of the morphologists, and so far as they are suited to the aims of the *Naturalist* to publish them.

The American Journal of Physiology. — In the beginning it was supposed that this new journal would occupy the field of general physiology as well as that of the more special applications of this science. As a matter of fact, the first volume is almost exclusively physiology of the medical schools, and the second volume promises much the same. Criticism is not directed toward the editorial board of the new journal, but toward the younger physiologists, who are working on general problems, but who have not supported the journal by their contributions.

Laws of Priority. — One of the most notable works which has appeared on our table for several years is the *Fishes of North and Middle America*, by D. S. Jordan and B. W. Evermann. These 3136 pages represent an immense amount of work, but, to our mind, they are marred by too strict an adherence to the laws of priority. In the interpretation of the statutes of our legislatures the judges of our courts are allowed the exercise of common sense ; should not the same latitude be permitted in the applications of the laws of nomenclature? These laws are of human manufacture ; they are framed, not by the whole body of scientific workers, nor by their representatives, but by the few ; and their application without modification leads to endless confusion. A case in point is illustrated by these volumes. For years the pickerel, pike, etc., have been assigned to a

genus universally called Esox, but in these volumes the name Esox is transferred to the genus known since 1817 as Belone, while to the genus containing the pikes the name Luccius is applied. These changes are based upon the writings of Rafinesque, and if persevered in will lead to endless confusion. A few such changes and the scientific literature of America will be unintelligible to the students of Europe.

That the scientific world is not a unit in regarding the law of priority as inviolable is shown by their treatment of a somewhat similar case, where the attempt was made to change the names of many of the Lepidoptera upon the authority of Hubner's *Tentamen*. A strict adherence to the rule must result in the adoption of the Hubnerian names, but our entomologists will have none of them. If our systematists must have immutable laws, would not a law of limitation be a good one? Would it not be well to say that if a certain name has been in common use for, say fifty years, it shall not be replaced by some long-forgotten name, resurrected by some delver in antiquarian lore. That our radicals will not be followed by the more conservative Europeans is shown by numberless facts. No European naturalist will discard Amphioxus; Triton will hold its own in place of Triturus or Molge; and Dr. Boulenger hopes that a similar conservative spirit will work in the interests of stability in the nomenclature of the tailless batrachians of Europe.

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

Origin of Culture.[1] — Notwithstanding the classical works of Bastian, Ratzel, and Tylor upon culture history, and the papers of others scarcely less eminent, L. Frobenius, in his treatise upon African Culture, deplores the fact that so little has been done to discover the origin of culture and that so little is known of the true "world-history." He compares the present state of culture with the joint or internode at the top of a bamboo stem. That which is beneath our internode is unknown to us; in whatever direction we may turn we are confronted by unsolved ethnological problems, so that our examination of the records of the past speedily terminates in the Aryan, Babylonian, and other questions. The author makes the usual observation in regard to the need of haste in gathering information and specimens from those inferior races who are being civilized off the face of the earth. A noteworthy feature of this memoir is the stress laid upon the "natural history method" of treatment. Frobenius declares that much has been heard of this method but little seen. Culture is continually compared to a living organism that has its birth, development, and decay; it is borne about by man, but changes much more slowly than he; it is through its study that we shall learn of the migrations of men and come to know something of the greater world-history. About 200 pages are devoted to the study of the "morphology" and the "comparative anatomy" of African culture, in which the internal structure, outward form, and the distribution of the huts, weapons, implements, and other artifacts are described in detail. Perhaps the most originality appears in the third part of the work, which is devoted to the "culture-physiology" of Africa. By this is meant the status of each art in its own particular life cycle; the declining and stationary arts include those of Negritic and Malay-Negritic origin, now represented by artifacts in wood and bamboo; the developing technic arts are of Asiatic and African origin, and are confined chiefly to articles of iron, hide,

[1] Frobenius, L. *Der Ursprung der afrikanischen Kulturen.* Berlin, Gebrüder Borntraeger, 1898.

and leather. Much that has been classed as "techno-geography" and "anthropo-geography" is included in this memoir under "culture-physiology." Frobenius has made a decided gain in lucidity and directness of presentation of his subject by employing this formal nomenclature; in less skillful hands it might lead to the warping of facts to fit them to the plan of research.

A series of 26 charts accompanies the volume upon which the various culture areas are indicated. There is a fascinating appearance of finality about such diagrams, yet, owing to the many sources of error in museum records, from which the charts were made out, they must at best be regarded as provisional and incomplete. The value of the memoir is enhanced by numerous illustrations in the text.

FRANK RUSSELL.

GENERAL BIOLOGY.

Embryos without Maternal Nuclei.[1] — By separating by hand under the microscope the unfertilized egg of the sea-urchin, Delage has obtained one part containing a nucleus and ovicenter and a part devoid of them. When these parts were placed in a drop of water containing a normal egg and spermatozoa were added, spermatozoa entered into all three pieces and all cleaved. The whole egg developed the most rapidly, the nucleated fragment came next, and the enucleate fragment most slowly. All were carried to the gastrula stage; the embryo without maternal nuclei being of small size and having the enteric and blastocœlic cavities nearly obliterated. Thus there has been effected the fecundation and development of a fragment of an egg without egg nucleus and without ovicenter. Delage draws the following weighty conclusions: —

1. It is necessary to reject as too strict the ordinary definition of fecundation — the union of the male and female pronuclei. This union occurs, but is not the essential phenomenon.

2. The definition of Fol — the union of two pronuclei and of two demi-ovicenters with two demi-spermcenters — must also be rejected. It must be rejected also on account of the often observed fact that the absence of the ovicenter offers no obstacle to segmentation.

3. Any theory must be rejected which explains fecundation by the saturation of a female nuclear polarity by a male nuclear polarity,

[1] Delage, Yves. Embryons sans noyau maternel, *Compt. Rend.*, 1898.

and also the theory that accounts for maturation on the ground that it is getting rid of the male element of an originally hermaphrodite egg nucleus.

4. All theories must be rejected which consider fecundation as the furnishing by the male of the number of chromosomes subtracted by the polar globules. The loss of one-half of the chromatic matter does not, of itself, prevent the egg from developing, for the half number of paternal chromosomes can make the egg develop.

5. The sexual attraction is not located in the nucleus.

6. Two things must be distinguished in fecundation: (*a*) the communication to the egg of a vital energy which permits it to segment and to develop; (*b*) the communication to the product of the advantages resulting from amphimixia and the possession of the paternal hereditary characters. As for the second point, my experiment furnishes no indication; as for the first, it shows that the theories of fecundation reconcilable with it are those which present the phenomenon as the conveyance by the male of a special energetic plasm (*Kinoplasma*) contained perhaps in the spermocenter.

7. There is in the ovular cytoplasm no fixed specific architecture whose conservation is a condition of development; if a structure exists, it is conditioned by the mutual reactions of parts and can reëstablish itself as often as it is altered.

8. The celebrated experiment of Boveri, so strongly contested, especially by Seeliger, is demonstrated, if not true, at least possible: the gravest objection that has been made to it (the impossibility of the development of an ovular cytoplasm without nucleus) being experimentally suppressed.

Temperature and Rate of Regeneration.[1] — It has long been known that in every organism there is an optimum temperature for growth above and below which growth occurs more slowly. That the same is true of regeneration has been shown by the recent work of Lillie and Knowlton on *Planaria torva.* Miss Peebles has done similar work on *Hydra grisea* and *H. viridis.* At 18–24° C., of *H. grisea* there regenerated in 2 days 0%; 3 days, 26%; 4 days, 95%; of *H. viridis*, 2 days, 38%; 3 days, 100%. At 26–32° of *H. grisea* there regenerated in 2 days, 75%; 3 days, 100%; of *H. viridis* in 2 days, 98.5%; 3 days, 100%. At 12° C. there regenerated of *Hydra viridis* in 4 days, 13%; 5 days, 24%; 6 days, 71%; 7 days, 100%.

[1] Peebles, Florence. The Effect of Temperature on the Regeneration of Hydra, *Zool. Bull.*, vol. ii, pp. 125–128.

At 38° C. polyps did not regenerate, but died. Hence the optimum lies between 30° and 38° C. *H. grisea*, at the room temperature (18–24° C.), regenerates more slowly than *H. viridis;* but it is relatively more accelerated by the increased temperature.

Experiments upon the relative effect of light of different wavelengths resulted negatively; but these experiments do not seem to have been carried out very thoroughly.

Organisms and Oxygen.[1] — That oxygen is necessary to the life of organisms is a dogma which seemed to have received a severe shock when the facts of anærobic bacteria (which are killed by the presence of free oxygen) became known.

Errara points out that after all this necessity for oxygen is one of degree. As there are certain species which need a large amount of oxygen, so there are others which have a very low optimum of oxygen supply; such are the anærobic forms. In the presence of a larger amount of oxygen they thrive less well, and may even die.

The Phylogenetic Significance of Protozoan Nuclei.[2] — The minute structure of the nuclei of Tetramitus, Microglena, Synura, Chilomonas, Trachelomonas, Stylonychia, Amœba, Euglena, Ceratium, Peridinium, and Noctiluca has been carefully investigated by Mr. G. N. Calkins. A considerable variety of nuclear types is recognized, the simplest of which is the distributed nucleus, which consists of isolated chromatin granules scattered about in the cell. Nuclear membrane and linin threads are absent; there is, however, a cytoplasmic body near which the chromatin granules gather at the time of division; the activity of this body is analogous to that of the centrosphere of more highly organized cells. Nuclear conditions of this type are found in Tetramitus. A higher form of structure is found in the "intermediate" type of nucleus which occurs in Microglena, Synura, Chilomonas, the euglenoids, in which the attraction-sphere is intranuclear, definite in form, deeply staining and active, and the chromatin granules are massed about it permanently, as in the forms just mentioned, or only during division, as in Paramœba. A nuclear membrane is found in the case of some nuclei of this "intermediate type." In higher types of nuclei the attraction-sphere is no longer intranuclear, but this position of vantage is taken by

[1] Errara, L. Tous les êtres vivants ont-ils besoin d'oxygène libre? *Rev. Scientifique*, (4) X, 688, 689, 26 Nov., 1898.

[2] Calkins, Gary N. The Phylogenetic Significance of Certain Protozoan Nuclei, *Annals N.Y. Acad. Sci.*, vol. xi (1898), pp. 379–400, Pl. XXXV.

the central spindle during division as in Noctiluca and many Metazoa. A distinct centrosome was found only in Noctiluca. The nuclei of most Protozoa belong, however, to aberrant types, which seem to have developed along divergent paths and only remotely resemble the more primitive forms on the one hand and the higher forms on the other. Examples of these aberrant types are found in *Amœba proteus*, Ceratium, Noctiluca, and the Infusoria in general. Chromosome formation is first seen in flagellates in the form of rods which arise by the union of the scattered chromatin granules. They form in the typical, though primitive, metazoan manner in Noctiluca and Euglypha, and all metazoan cells pass through these stages in preparing for mitosis. C. A. K.

The Plotting of Biological Data in which it is necessary to exhibit an enormous range of numbers, as, for example, in certain lines of plankton work, presents a practical difficulty which may be obviated by a simple method suggested by Mr. D. J. Scourfield.[1] This is the use of logarithmically ruled paper, or of ordinary cross-section paper by the assignment of suitable values to the lines. Thus millimeter paper may be used if the centimeter lines are held to represent 1, 10, 100, 1000, etc., and the intermediate millimeter lines are given the numerical values whose logarithms are 0.1, 0.2, 0.3, 0.4, etc. For ordinary biological data, logarithmic ruling in one direction only is required, though for certain problems, *e.g.*, the plotting of variations of a rapidly increasing number of organisms, paper ruled in this manner in both directions might be used. This method of graphic presentation of biological statistics has the additional advantage of exhibiting *proportionate* changes in numbers by lines having the same angle of slope wherever situated in the chart.

C. A. K.

ZOÖLOGY.

Relationships of North American Grouse and Quail. — Dr. H. L. Clark has just published one of his useful papers on the feather-tracts of birds; in this case on those of the North American grouse and quail. The work of Nitzsch is thus carried on and[2] extended,

[1] Scourfield, D. J. The Logarithmic Plotting of Certain Biological Data, *Journ. Quek. Micr. Club*, Ser. II, vol. iv (1897), pp. 419–423, Pl. XX.

[2] Clark, Hubert Lyman, Ph.D., Instructor in Zoology, Amherst College. The

Dr. Clark having the advantage of almost exclusively basing his observations on fresh birds instead of dried skins, thereby escaping many errors unavoidable to his predecessor and being enabled to go into such details as are demanded by the more refined requirements of modern science. Thus, while Nitzsch only examined the skins of 5 species within the frame of Dr. Clark's article, the latter could work with 65 specimens in the flesh, representing 18 species and all the genera of the territory in question. His careful descriptions and figures are, therefore, very valuable to the systematic ornithologist, and the conclusions he bases upon them entitled to great consideration. But while thus restricted to fresh material, he is also limited to a small number of forms of the groups he treats of, and while this limitation in no way lessens the usefulness of the material, which he thus places in the hand of the working systematist, it naturally interferes with the trustworthiness of the generalizations.

In discussing his "conclusions" (pp. 651–653) it should be borne in mind, however, that Dr. Clark has been very careful and guarded in expressing his views, and that he has avoided to be dogmatic; nor does he claim that much light has been shed upon the origin or relationships of the larger groups. The relationships of the various genera within these groups, however, he thinks "is at least suggested by these investigations" to the extent that he ventures to express them in diagrams which look suspiciously like "stammbaums." But I am not certain that they mean more than a diagrammatic representation of the pterylographic "relationships" without reference to the true phylogeny of the species, unless he really believes that the pterylographic characters alone are sufficient to indicate the various shades of interrelation or the course followed in the evolution of these genera. This uncertainty is indicated by his speaking of the diagrams as "pointing out the relationship of the genera," though in the next moment he selects a type at the bottom of the series simply for the practical convenience of having "a starting point from which to develop the other genera." Seeing, however, that the diagrams have no real value unless meant for "ephylogenetic trees," whether standing on their roots or their tops, I shall discuss them from the latter point of view.

It is then plain that Dr. Clark, in spite of his guarded reservation, really regards the trees as standing on their roots, for he is careful to select the genera he starts from, on account of characters which

Feather-Tracts of North American Grouse and Quail, *Proc. U. S. Nat. Mus.*, vol. xxi (1898), No. 1166, pp. 641–653, Pls. XLVII–XLIX.

he claims to be more generalized than those of the other genera. As one of these generalized characters he regards the small number of rectrices, assuming that the forms with more numerous tail-feathers have increased them in the course of development. Thus he remarks that "*Dendragapus* has developed from *Canace* by . . . a marked increase in the number of rectrices." I think there can be no doubt that this is a fundamental error. The whole development of the tail of the birds shows that the generalized condition is that of numerous rectrices, and that the specialization, so far as number goes, consists in their reduction. I doubt very much that a pair of rectrices once *lost* can ever be redeveloped. If a reduction has already taken place and for some cause or another the tail is to answer a purpose temporarily suspended during the course of the evolution of a form, other feathers which have not undergone the retrograde movement are taken into employ and developed so as to serve the same purpose. Thus in many cases the upper tail-coverts have had to function as rectrices, with the result that very often it is difficult to tell them apart structurally from the true rectrices, while in one case, at least, the under tail-coverts have so completely assumed the rôle of the tail that they were generally regarded as true rectrices until it was discovered that the so-called tail-feathers were turned completely underside up!

I believe it is equally erroneous to assume that a structure so highly specialized as the "top-knot" of the California Partridge (*Lophortyx*) could be changed into the simple structure of the Mountain Partridge (*Oreortyx*), and while admitting the possibility of its disappearance and the development of the other feathers on the crown into a loose crest like that of the Scaled Partridge (*Callipepla*), I see no necessity for such an assumption, especially as the latter seems to show no apterium on the top of the head to account for the lost special tract. The more natural explanation seems to be to regard all these forms as having originated independently from more generalized types.

But apart from this last objection, which is one of detail, it will not do to turn Dr. Clark's trees upside down; they will not give us the true ascent of the genera, for the reason that he has assumed them to descend directly from the most generalized living form. He has not taken into account the fact that the genus among the extant forms, which in its totality shows the greatest amount of generalized characters, may have acquired one or more highly specialized peculiarities, thus showing that it is somewhat outside the direct line of ascent.

We shall now apply these principles in an attempt at reconstructing the genealogic tree of the North American partridges or quails, chiefly from the pterylographic characters.

In viewing these forms it seems thus evident that we have two groups, the members of which bear closer relationship to each other than to those of the other group. On the one hand, we have *Colinus* and *Cyrtonyx;* on the other, *Callipepla*, *Oreortyx*, and *Lophortyx*. The relationship of the former is obvious. The speckled-backed *Cyrtonyx* cannot well have developed through stages like those of the plain-backed *Lophortyx* and *Callipepla*, as suggested by Dr. Clark; and this character alone goes a long way to show the more generalized status of *Colinus* and *Cyrtonyx*. *Cyrtonyx*, with its higher developed crest, differentiated ventral feather-tract, reduced tail, and wanting claw to the thumb, is manifestly the more highly specialized form, thus leaving *Colinus* on the bottom round of the ladder. This is the same position given it by Dr. Clark it will be observed. The only difference between us is that he places it there because, among other generalized characters, it possesses 12 rectrices, while I give it a similar place *in spite* of this fact. By placing it lower than *Callipepla*, with 14 rectrices, I suggest that while *Colinus* has already lost a pair, *Callipepla* is, on the whole, a more specialized form, in spite of the fact that it has retained the greater number of rectrices. If, therefore, the two groups of quail have a common origin, this ancestor is obviously below the line of the beginning of our tree, having in all probability a speckled plumage like *Colinus*, 14 rectrices and 16 secondaries.

Of the 3 members of the second group it is only necessary to say that *Callipepla*, with its 14 rectrices and loose crest, is the more generalized form, probably descended from an ancestor with 16 secondaries, by reduction to 14. From this ancestor *Oreortyx* ascended, on the one hand, by further specializing the crest, though retaining the 16 secondaries; while, on the other hand, *Lophortyx* lost two of the latter, besides assuming a still more complicated top-knot.

Assuming, then, the common origin of these genera, I substitute the following diagram as probably representing more nearly the true course of the development diagram of these forms.

The question of the genealogy of the North American *Tetraoninæ* is one greatly more complicated, for the reason that two of the genera apparently hold closer relationships to forms not occurring in this hemisphere than to the genera which are restricted to our continent.

Obviously *Bonasa*, with its partly naked tarsus, a very unusual thing in this group, stands apart from all the other American genera, and the fact that it has developed a special feather-tract on each side of the neck does not necessarily indicate any close relationship with *Tympanuchus*, much less that it has an origin in common with the latter. The general characters of *Lagopus* do not seem to imply a *special* relationship to *Canace*, and may only mean the greater lack of specialization of both and their comparative nearness to the common ancestor of all the grouse. *Centrocercus*, on the other hand, shows a number of extremely specialized characters alongside of the retention of generalized ones, and while it may share origin with *Pediocætes*,

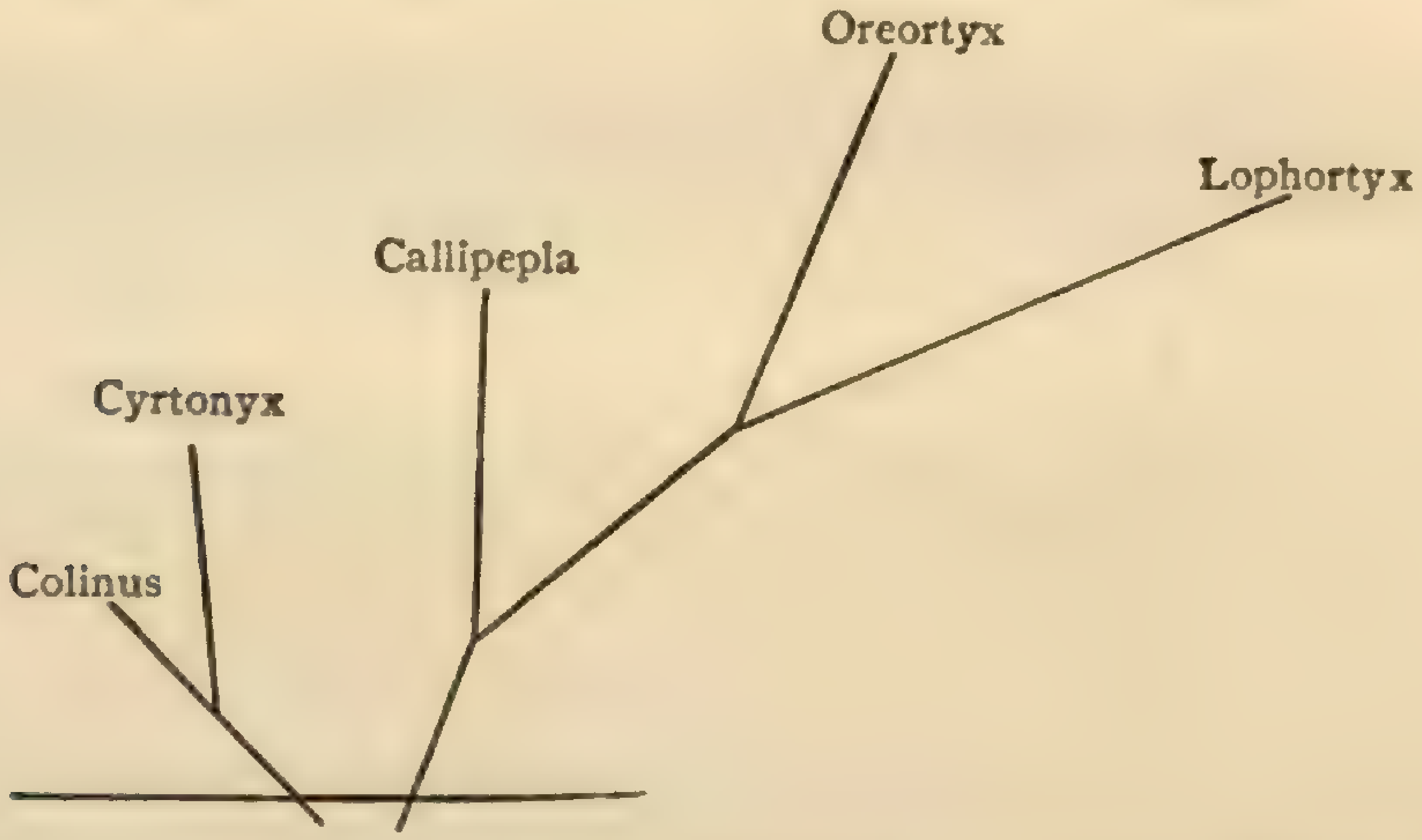


Diagram illustrating the possible development of the North American quail as divulged in their pterylographic characters.

there is no reason for believing that they have descended from *Canace*, which seems more closely allied to *Dendragapus* and *Tympanuchus* in spite of the specialization of the neck-tracts of the latter.

It is to be hoped that Dr. Clark may be able to carry his investigations on fresh material in this field farther, and especially that he may succeed in extending it to more forms of the so-called peristeropod Gallinæ, the Curassons and Guans, in Central and South America. He may then be able to point to more definite and trenchant characters between them and the alecteropods, in which connection I would call attention to the alleged presence of a "bastard secondary" in the latter and its absence in the former. The peristeropods are, on the whole, considered to be more generalized, but highly specialized pterylographic features are apparent in many forms — a feature which should not obscure the general proposition.

LEONHARD STEJNEGER.

Gegenbaur's Comparative Anatomy of Vertebrates.[1]— For some years past rumors of a revised edition of Gegenbaur's *Vergleichende Anatomie* have been circulated by the European book-dealers, and even after the appearance of the masterly works of Lang, and of Korschelt and Heider, of Wiedersheim and of Hertwig, it must be confessed that the older text-book, if rewritten in the broad philosophical spirit that Gegenbaur accords to all his work, would have been no mean rival to the best that we have. Wisely or unwisely, Gegenbaur has not chosen to undertake the whole of this task, but has limited himself to a revision and expansion of only the vertebrate portion of his former text-book. The volume now published is about one-half of the new work, which even in its present state is more voluminous than the whole of the last edition of the *Comparative Anatomy*. The rest, we are told, is mostly written and may be expected within a year. When it is remembered that since the time of Owen no one perhaps has influenced the course of vertebrate comparative anatomy more profoundly than Gegenbaur, and that in the full strength of his years he now presents the results of a lifelong study, the monumental character of his work must be apparent.

The present volume contains nearly a thousand pages. After an introductory section the following systems of organs are treated: the integument, the skeleton, the muscular system, the nervous system, and the sense organs. The text is in two sizes of type, the smaller being reserved for less important topics. As a rule, most topics are followed by a brief list of the more important papers dealing with them. There is no index, but an extremely methodical arrangement and a detailed table of contents make this omission less noticeable. The text is illustrated by 619 figures, some of which are colored. The paper and presswork, while not the best, are uniformly good.

The new work is striking for the completeness with which the comparative method is applied. Thus, in the former editions, the integument of vertebrates was considered under three heads: the integument proper, epidermal structures, including glands, and the dermal skeleton. In Wiedersheim's *Lehrbuch*, which appeared some five years after Gegenbaur's last edition, a classification of the subject even to this slight extent was omitted, and the treatment of the integument lapsed into the purely descriptive form of a section on the integument of each group of vertebrates. In the new volume

[1] Gegenbaur, C. *Vergleichende Anatomie der Wirbelthiere mit Berücksichtigung der Wirbellosen.* Erster Band. Leipzig, W. Engelmann (1898), xiv + 978 pp., 619 figs.

Gegenbaur builds on his former arrangement: under the head of integument we find chapters on the epidermis, the corium, and the pigment; under organ-formation of the integument are placed in sequence horny structures, skin glands, mammary organs, scales and feathers, and hair; finally there is a chapter on the dermal skeleton. While this classification may not be ideal, it has the great advantage of bringing together those organs which are most likely to form natural series. It is obviously much more in accord with the traditions of comparative anatomy to consider, for instance, integumentary glands under one head than to scatter them through a descriptive account of the integument of different groups of vertebrates. In this respect Gegenbaur has made a positive advance, and the shortcomings which his system may eventually show will doubtless be found to have been the result of what is at present undiscovered rather than of any lack of appreciation on the part of Gegenbaur as to what the comparative method implies.

The volume is so replete with material which, if not exactly new, is at least first brought together in compact form, that it is practically impossible to review it in detail. It is interesting, however, to observe the position assumed by Gegenbaur on several important questions with which he has been closely associated in the past. Thus, on the relation of the marsupium to the mammary pockets he maintains his original opinion that these organs are essentially distinct, although Klaatsch has recently shown that it is quite possible that the marsupium has arisen by a fusion of mammary pockets. On the question of the origin of the lateral appendages Gegenbaur stoutly defends his original contention that these parts probably represent modified gill-arches, his general argument being that it is safer to assume that the lateral appendages have come from gill-arches about which we know something than it is to suppose them derived from a continuous lateral fin about which we know little or nothing. In matters of theory the volume is strikingly conservative, and this conservatism is in some respects an advantage. Thus, in the treatment of the cranial nerves the parts are fully and well described, but the account is not concluded with a tabulation in which some more or less imaginary segmental value is assigned to each nerve. In this respect Gegenbaur's treatment of the subject seems to us wisely out of style.

It would deservedly be a thankless task to point out the small inaccuracies which this, like all other books, contains. The omission of a pisiform bone from the carpus of the snapping turtle (p. 529),

and the description of the membrana tectoria as a cuticular structure (p. 890), may be contrary to fact, but they are blemishes which disappear in the marvelous wealth of accurate information which fills the whole work.

The place that the new *Anatomy* will find is not difficult to predict. Its size and fullness, together with the heaviness of Gegenbaur's style, will probably prevent it from being a popular text-book with most beginners, but its masterly qualities will make it an absolute necessity to every advanced student of vertebrate anatomy. In this respect it will occupy the field formerly held by Wiedersheim's *Lehrbuch*, though it seems to us unlikely that it will replace in any extensive way this author's *Grundriss*, which from its elementary character and simple language makes so satisfactory a book for the beginner.

The heavy debt which vertebrate anatomists already owe to Gegenbaur is materially increased by this accession to the list of best text-books, and it must be the wish of every one that circumstances may favor the early completion of a work destined to be so scholarly and valuable a contribution to the comparative anatomy of the vertebrates.

G. H. P.

The Natural History and Morphology of Dero vaga.[1] — This interesting little aquatic worm was described twenty years ago by Dr. Joseph Leidy[2] in this journal as *Aulophorus vagus*. It is found in shady places among vegetation in ponds and ditches, living by preference among masses of floating Lemna or among algæ on the bottom, shifting its position gradually from surface to bottom or *vice versa*, according to the location of food supply. Its food consists of vegetable matter, principally desmids, algæ, and even the fronds of Lemna. The worms inhabit cases which they construct of statoblasts, Arcella shells, the leaves of Lemna, etc. The cases of individuals living at the surface float, and those of individuals living at the bottom sink when the worms are removed. The period of sexual reproduction occurs during the first two weeks of July, when the body cavity posterior to the clitellum is crowded with eggs. Asexual reproduction by fission takes place throughout the year, but most rapidly during warm weather, when it may occur as often as

[1] Brode, H. S. A Contribution to the Morphology of Dero vaga, *Journ. of Morph.*, vol. xiv (1898), pp. 141–180, Pls. XIII–XVI.

[2] Leidy, J. Notice of Some Aquatic Worms of the Family Naids, *Am. Nat.*, vol. xiv (1880), pp. 421–425.

three times a week. Three fission zones have been observed in one individual at the same time. As the animal grows in length, the case which it inhabits is extended, and after fission the two daughter-worms divide it by placing their heads together at its middle and forcibly breaking it; each worm then swims away with one-half of the old case. The fission zone is formed near the middle of some segment, usually back of XVII and in front of XXII. The new head and tail are almost completely formed before separation takes place. The number of somites in the new head is constant, being five, while twelve to sixteen segments are visible in the tail before a second fission begins. Worms divided by cutting regenerate the missing part, though only enough segments are regenerated at the anterior end to complete the cephalized portion, *i.e.*, the first five. Thus if two are removed but two regenerate, while if seven are taken away only five new segments are formed. At least three or four segments in addition to the five in the cephalic region are necessary for the regeneration of the tail. Dr. Brode gives a detailed account of the structure of the body wall, of the nervous system, and of the sense organs. Each segment is provided with four lateral nerves which arise from the ventral ganglion and pass to the body wall and thence dorsally. The epidermis is provided with a remarkable series of sense organs, each segment bearing two series arranged in greater and lesser circular bands of twelve and eight organs respectively. These organs are so spaced as to form twenty longitudinal rows extending the whole length of the body. Dr. Brode also confirms Hesse's view that the so-called lateral line of oligochetes is formed by the accumulation of the nucleated plasma portions of the circular muscle fibres and cannot, therefore, be interpreted as a nervous structure. The epidermal sense organs have no share in the formation of this line. The marked serial symmetry of the epidermal sense organs and lateral nerves is held by the author to support the colonial theory of the origin of metamerism.

C. A. K.

Crustacea of Florida and the Bahamas. — Miss Mary J. Rathbun is an indefatigable student of Crustacea. In fact, the mantles of Stimpson, Smith, Kingsley, Say, Gill, Gibbes, and all other past students of the group appear to have fallen on her shoulders. In the paper before us she describes the 127 species of brachyma, collected by the Iowa University Expedition of 1893.[1] Several new

[1] *Bulletin of the Laboratories of Natural History of Iowa University*, June, 1898.

species are described, and there are notes on others not so well known. As in all of Miss Rathbun's work, the recognition of salient characters is acute, and their expression is put in concise form. One or two features which persistently reappear in her writings seem to call for criticism. Apparently the attempt is made to arrange the species on a descending scale, for the series begins with the Maioids and ends with the Calappoids, but certainly the Ocypodoids are the highest of the Decapods. The other feature of which we would complain is the foundation of new genera (*e.g.*, Eupanopens) upon characters of far less than generic value. Certainly the characters given in the following diagnosis are not of generic value. Carapace of moderate width, anteriorly subquadrate, crossed by broken transverse lines; frontal lobes sinuous; five distinct lateral teeth, the third, fourth, and fifth prominent, the second usually so. One feature of the collection is interesting — the absence of any specimens of Gelasimus.

Entomostraca of Karelia. — An extended faunistic study of the Entomostraca of Karelia in the region tributary to the White Sea has been made by Dr. K. E. Stenroos.[1] Especial attention was given to the Cladocera, of which 64 forms — an exceptionally large number — were found. Species are grouped as littoral or limnetic, though a few are members of both faunas and exhibit marked differences according to their environment. When found alongshore or in weedy shallows of the lakes they are opaque and brownish, while in open water they have the hyaline appearance characteristic of the typical limnetic fauna. Great variation was observed within the genus Bosmina, almost every body of water showing its own peculiar type. Wherever adjacent lakes presented similar physical characteristics the Bosminidæ found therein were much alike, but the more diverse the environment, the greater the unlikeness of the Bosmina fauna. Intermediate forms were found which seem to render necessary a considerable reduction in the number of species hitherto recognized in this genus. *Chydorus rugulosus* Forbes, originally described from Lake Superior, is reported from Finnish waters. C. A. K.

Notes. — The interesting amphibian, *Amphiuma means*, is reported by H. M. Smith in the *Proc. of the Nat. Museum*, Vol. XXI, as occurring in the vicinity of Hampton, Virginia, where it was found in some

[1] Stenroos, K. E. Zur Kenntniss der Crustaceen-Fauna von Russisch-Karelien, *Acta Soc. pro Fauna et Flora Fenn.*, Bd. xv.

numbers by workmen while excavating for an electric railroad. This extends the distribution of the species by some 110 miles to the northeast, the furthest station previously recorded in this direction being, according to the National Museum collections, Tarboro, North Carolina.

Number 4 of the eighth volume of the *Journal of Comparative Neurology* contains, beside the usual literary notices, the conclusion of Dr. Adolf Meyer's Critical Review of the Data and General Methods and Deductions of Modern Neurology, and Professor H. H. Donaldson's Observations on the Weight and Length of the Central Nervous System and of the Legs in Bullfrogs of Different Sizes.

Number 3 of the second volume of the *Zoölogical Bulletin*, issued in December of the past year, contains Notes on the Finer Structure of the Nervous System of Cynthia partita, by G. W. Hunter, Jr.; The Maxillary and Mandibular Breathing Valves of Teleost Fishes, by U. Dahlgren ; The Effect of Temperature on the Regeneration of Hydra, by F. Peebles ; and Further Notes on the Egg of Allolobophora fœtida, by K. Foot and E. C. Strobell.

Dr. Arthur Willey describes a new Peripatus from New Britain, but very distantly related to any of the previously known species, which is placed in a new subgenus, Paraperipatus. Dr. W. M. Wheeler describes *P. eiseni* (*Journ. Morph.*, Vol. XV, p. 1), from Mexico.

BOTANY.

Some Recent Elementary Text-Books. — No two teachers present a subject in the same manner, and to attempt to compel them to do so, as is done in some public school systems, usually makes automata of them and machines of their pupils, when nature work is involved. But the yearning of every good teacher for some reference book that he can put in the hands of his class, giving them what he cares to have them know and freeing them from the expense of paying for other matter, seems scarcely capable of expression otherwise than in the preparation of a text-book of his own. Four such books have recently come to hand, one quite elementary, the others aiming at the work done in the secondary schools or by the most general of college classes.

Professor Bailey,[1] with a horticulturist's bias, most admirably teaches both pupil and teachers how to study twigs and buds, leaves and foliage, flowers, fructification, propagation, the behaviors and habits of plants, and the kinds of plants — to which he adds suggestive paragraphs on pedagogical methods, books, classification, evolution, and the interpretation of nature and the growing of plants. Nothing could be better in its way — and it is a very good way — than this addition to the products of the pen of a versatile and prolific writer.

Professor Barnes,[2] from the point of view of the physiologist, attempts to exhibit to pupils 13 to 18 years of age, who are engaged in genuine laboratory study, the variety and progressive complexity of the vegetative body, to explain the unity of plan in both the structure and action of the reproductive organs, and to give an outline of the more striking ways in which plants adapt themselves to the world about them. It is to be feared that he has aimed over their heads.

Professor Atkinson,[3] perhaps with less leaning toward any one side, gives fourteen chapters to physiology, twenty-one to morphology, eight to lessons on plant families, and thirteen to ecology.

Each of these books is good. If one could have only one of them, he would probably choose the first or the last noticed, which happen to come from the same faculty — that of Cornell University. But the point of view is so different that whichever he had, he would wish to complement it with the other — or to write his own book. T.

Rhodora[4] is the euphonious title of a new journal, started with the current year, by the New England Botanical Club. It is well gotten up, and under the editorship of Dr. B. L. Robinson, of the Gray Herbarium of Harvard University, it is sure to be well conducted. The initial number contains the following articles: Fernald, Rattle-

[1] Bailey, L. H. *Lessons with Plants.* New York, The Macmillan Company, 1898. Pp. xxxi + 491, 446 ff. — *First Lessons with Plants*, being an abridgment of *Lessons with Plants.* New York, The Macmillan Company, 1898. Pp. x + 117, 116 ff.

[2] Barnes, C. R. *Plant Life Considered with Especial Reference to Form and Function.* New York, Henry Holt & Company, 1898. Pp. x + 428, 415 ff.

[3] Atkinson, G. F. *Elementary Botany.* New York, Henry Holt & Company, 1898. Pp. xxiii + 444, 509 ff.

[4] *Rhodora*, Journal of the New England Botanical Club. Price, $1.00 per year ($1.25 to all foreign countries, except Canada). Editorial communications to be addressed to B. L. Robinson, 42 Shepard Street, Cambridge, Mass. Subscriptions, etc., to W. P. Rich, 3 North Market St., Boston, Mass.

snake-plantains of New England; Brainerd, Saniculas of western Vermont; Collins, Notes on algæ, 1; Deane, A prolific gentian; Williams, Myosotis collina in New England; Robinson, A new wild lettuce (*L. Morssii*) from Massachusetts; Webster, Notes on some fleshy fungi found near Boston; Manning, Matricaria discoidea in eastern Massachusetts.

The Gametophyte of Botrychium virginianum.[1]—Until this publication of Mr. Jeffrey our knowledge of the development of the embryo of Botrychium was practically none, and the previous accounts of the prothallus have been very insufficient. The material used in his investigation was gathered in its natural habitat — a sphagnum bog in which he found an abundance of prothalli in all stages. Owing to the extreme delicacy of the objects, great difficulty was experienced in mining them into paraffin. An ingenious dialyzer rotated by clock-work was employed to insure the more gradual yet sufficiently rapid osmosis between the benzole and the alcohol.

The gametophyte of *B. virginianum* is subterranean and without chlorophyll, and harbors a fungus of a phycomycetous type which the author regards as possibly symbiotic with the prothallus. On the gametophyte, which is oval in shape and beset with rhizoids, are borne both the antheridia and archegonia. The former above the latter on the sides. The antheridia, which develop from a single superficial cell, possess a double outer wall like those of other Ophioglossaceæ known, and the antherozoids are of the usual type of the Filicineæ. The archegonium is somewhat less elaborate than that of the typical fern, and it is to be noticed that the canal cell while binucleate does not show any division of its protoplast. In the development of the egg-cell the usual divisions forming the octants are seen, but the walls of the latter soon lose their identity and the embryo is relatively many-celled before the organs appear. The root, shoot, and cotyledon originate from the upper part of the embryo — *i.e.*, probably the upper octants. The cotyledon is apparently a secondary formation in the region of the shoot. The foot which is large arises from the whole lower portion of the embryo. The growing region of the root, shoot, and cotyledon is in each case a single apical cell. The root develops most rapidly at first, followed by the cotyledon, a reversal of the condition found in *Ophioglossum peduncu-*

[1] Jeffrey, E. C. The Gametophyte of Botrychium virginianum, *Trans. Canad. Inst.* (1896–97). Reprinted for University of Toronto Studies (1898), *Biol. Series*, No. 1.

losum. But in other respects the gametophyte and embryo of *B. virginianum* agrees with what is known of other Ophioglossaceæ. The author points out a similarity in form between the prothalli of *B. virginianum* and *Hycopodium annotinum*, while a likeness is also found in the same organs of *Ophioglossum pedunculosum* and *L. cernuuem* and *L. inundatum*, showing two types of the gametophyte in the Ophioglossaceæ as in the Lycopodineæ.

H. M. R.

Proteolytic Enzyme of Nepenthes.[1]—This paper is in continuation of one published by the same author in 1897. He concludes that the enzyme from the pitchers of Nepenthes is comparatively a very stable one. High temperatures and alkalis gradually lessen its activity, but do not completely destroy its power of digestion unless strong means are employed. The enzyme is of the nature of a tryptic ferment closely resembling that found in germinating seeds, like which it is active only in an acid medium. The author considers that he has fairly demonstrated the enzyme to arise from a zymogen in the gland cell of the pitcher.

H. M. R.

Nucleus of the Yeast Plant.[2]—According to this last account the cells of yeast certainly possess what the author terms a nuclear apparatus. This consists in the early stages of fermentation of what is called a homogeneous nucleolus in close contact with a vacuole containing a chromatin network. In later stages the "chromatin-vacuole" may have disappeared, the chromatin material being found as fine granules in the protoplasm. In the young stages there may be more than one "chromatin-vacuole," which later appear to fuse. The division which accompanies budding is direct, and takes place in the constriction between mother and daughter cell. If the author is properly understood, in spore formation the chromatin is absorbed by the nucleolus, to appear later in the form of fine grains (chromosomes ?). The nucleolus elongates into a dumb-bell shape in the division preceding spore formation, and then constricts into two. Subsequent divisions forming four or even more new nucleoli may take place. A wall forms around these, and the spores are formed. The author does not demonstrate very definitely the relation of the nuclear apparatus of the spore to that of the vegetative cell. It

[1] Vines, S. H. The Proteolytic Enzyme of Nepenthes (II), *Ann. Bot.*, vol. xii (December, 1898), pp. 545–555.

[2] Wager, Harold. The Nucleus of the Yeast Plant, *Ann. Bot.*, vol. xii (December, 1898), pp. 499–537, Pls. XXIX, XXX.

would be interesting to know the changes which take place in the subsequent growth of the spore. A full historical account precedes the paper. Corrosive sublimate and Gram's iodine solution are recommended for killing, while a variety of aniline dyes were chiefly used for staining. Sections were also made. The species studied are given as *Saccharomyces cerevisiæ*, *S. ludwigii*, *S. pastorianus*, *S. mycodenua*, and a red yeast.

H. M. R.

Botanical Notes. — Skeletonizing leaves, always an interesting occupation, and one of some scientific utility, is described in the number of *Science* for December 30 by A. F. Woods, who finds minute crustacea belonging to the genus Cypridopsis to be the active agent. So long as any parenchyma is present, they appear not to attack even the finer vascular bundles.

Under the heading "Foreign Weeds and their Extermination," Professor Pammel contributes an interesting little article to *The Gentleman Farmer Magazine* for November.

The forage plants and forage resources of the Gulf States are reported on by Professor Tracy in *Bulletin No. 15* of the Division of Agrostology of the United States Department of Agriculture.

Forestry in relation to physical geography and engineering is the subject of an article by John Gifford in the *Journal of the Franklin Institute* of July last.

"Check-List of the Forest Trees of the United States, their Names and Ranges," is the title of *Bulletin No. 17* of the Division of Forestry of the United States Department of Agriculture, by George B. Sudworth. It is stated to be in the main a condensed reproduction of *Bulletin No. 14* of the same division, like which it exemplifies the "Neo-American" views in nomenclature, and it is intended to be helpful in bringing about a more uniform and stable use of names by lumbermen, nurserymen, and others interested in forest trees.

The determination of woods by characters drawn from their structure, to which some attention has been given by engineers of late, forms the subject of an article by Charles Bommer, illustrated by twelve enlarged phototypes, showing the cross-section of as many woods, in the *Bulletin of the Société centrale Forestière* of Belgium for December.

Prof. T. H. McBride has published in separate form an instructive address on public parks for Iowa towns, which may well be read by the inhabitants of towns outside that state.

A provisional enumeration of the species of Cerastium is published by F. N. Williams in the *Bulletin de l'Herbier Boissier* of November 15.

The early botanical views of *Prunus domestica* are discussed by Prof. F. A. Waugh in the *Botanical Gazette* for December.

Whipplea Utahensis Watson is made the type of a new genus, Fendlerella, by A. A. Heller in the *Bulletin of the Torrey Botanical Club* for December, in which number he also makes of *Actinella Bigelovii* Gray the type of a new genus, Macdougalia.

The cockle-bur, *Xanthium strumarium*, which has been introduced into Queensland, is stated by F. M. Bailey, in the *Queensland Agricultural Journal* for November, to be poisonous to cattle, the effect being "to paralyze the heart, induce torpor, and cause death without pain or struggle."

The *Revue Horticole* of December 1 contains good figures of several of the forms into which *Dodecatheon Meadia* has passed in cultivation.

Fritillaria pluriflora of California is well figured in the *Botanical Magazine* for December.

Under the title *Mycological Notes*, Mr. C. G. Lloyd, of Cincinnati, began in November the issue of occasional bulletins on the fungi in his collection.

Sydow's *Deutscher Botaniker-Kalender für 1899* (Berlin, Borntraeger), is a handy little pocketbook which, among other things, tells under each day of some botanist who was born or died on that day of the month, gives a list of exsiccatæ of cryptogams, lists of botanic gardens and natural history museums of the world and of their principal plant collections, and the now familiar nomenclature rules of the Botanic Garden of Berlin.

The Plant World for December maintains the happy character of the journal for short botanical articles of general interest.

Vol. II of the *Annuaire du Conservatoire & du Jardin Botaniques de Genève*, in addition to a report on the establishment and lists of seeds collected, contains an important paper on the geographical limitation of species by the late Alphonse de Candolle, and systematic papers by Briquet, Lindau, Hochreutiner, and Casimir de Candolle.

The fourteenth volume of the *Acta Societatis pro Fauna et Flora Fennica* is entirely botanical: Wainio, *Monographia Cladoniarum Uni-*

versalis, III; Elfving, *Anteckningar om Kulturväxterna i Finland;* Mela, *Nymphæa Fennica, eine neue europäische Seerose.*

The *Ottawa Naturalist* for December contains No. 12 of the "Contributions to Canadian Botany," by James M. Macoun.

"Camping in Florida," a little article by Professor Hitchcock from *The Industrialist* (of the Kansas State Agricultural College) for November, tells how he contrived a wheelbarrow with pneumatic tire and ball bearings, on which he trundled the necessary outfit of a botanist 242 miles in 24 consecutive days, his expenses averaging 30 cents a day.

No. 15 of Dr. Small's "Studies in the Botany of the Southeastern United States," in the December number of the *Bulletin of the Torrey Botanical Club*, contains a rich grist of new species, especially in the genera Smilax, Oxalis, and Euphorbia.

The October number of *Monatsschrift für Kakteenkunde* contains a short note by Purpus on his season's botanizing in our western district.

Under the title "New Species of Plants from Mexico," Mr. Brandegee publishes several new binomials in *Erythea* for January.

PALEONTOLOGY.

Cretaceous Foraminifera of New Jersey.[1] — American literature is conspicuously deficient in works relating to the fossil Foraminifera, although in Europe the class has received the attention of some of the leading paleontologists, and their monographs and special reports cover the investigations of many years.

The present memoir includes the cretaceous Foraminifera from the marl beds of New Jersey, embracing the Monmouth, Rancocas, and Manasquan formations. The greatest number of species (seventy-nine) occurs in a limestone layer in the Rancocas formation. Four species are common to all four marl beds. Altogether there are one hundred and fifteen species now known from the New Jersey Cretaceans. The plates give unusually good representations of the form and structure of about thirty species of special interest. C. E. B.

[1] Bragg, R. M., Jr. The Cretaceous Foraminifera of New Jersey, *Bull. U. S. Geol. Surv., No. 88.* 8vo. 6 plates, 89 pp. Washington, 1898.

Cretaceous and Tertiary Plants.[1] — Botanists who are engaged in studying the plants of the Cretaceous and Tertiary formations will fully appreciate the service rendered by Professor Knowlton's latest contribution in the form of a catalogue of these plants, which have always had a special interest because of their often close connection with the flora of our own time. The catalogue possesses double value in that it not only records most of the species so far discovered, but includes also a full and valuable bibliography of the subject. It gives striking evidence of the very rapid growth of our knowledge of this flora during the past twenty years, a fact which becomes all the more apparent when we observe that a number of new species have been recorded since its issue.

Miocene Flora.[2] — In recent studies of the Miocene plants as found at Idaho City, Idaho (" Payette formation "), Professor Knowlton enumerates twenty-nine species, of which 59 per cent are recognized as new.

Permian Flora.[3] — One of the richest and most interesting deposits of Permian plants in France is to be found at Lodève, where the slates have supplied material which has been studied by Brongniart and others since 1830. Zeiller now reviews all the available material, and is enabled to announce the addition of six new species, of which five belong to the genus Callipteris.

Cretaceous Cycads.[4] — Within the last five years there has been brought together a somewhat remarkable collection of Cycads from the cretaceous formation of the Black Hills. They number 155 specimens of trunks in various states of completeness and preservation, and belong chiefly to Yale University. This material has been studied by Prof. Lester F. Ward, who finds that among different species the height varies from 12 cm. to 130 cm., the diameter from 4 cm. to 75 cm., and that in most cases they represent a type of

[1] Knowlton, Frank Hall. A Catalogue of the Cretaceous and Tertiary Plants of North America, *Bull. U. S. Geol. Surv.*, 1898.

[2] Knowlton, Frank Hall. Report on the Fossil Plants of the Payette Formation, *Eighteenth Annual Report U. S. Geol. Surv.* (1896–97), Pt. iii, p. 721.

[3] Zeiller, M. R. Contribution à l'étude de la flore ptéridologique des schistes permiens de Lodève, *Bull. Mus. Marseilles* (1898), Pt. i, vol. i, p. 9.

[4] Ward, Lester F. Descriptions of the Species of Cycadoidea, or Fossil Cycadean Trunks thus far Determined from the Lower Cretaceous Rim of the Black Hills, *Proc. U. S. Nat. Mus.*, vol. xxi (1898), pp. 195–229.

comparatively low form, in which the stem is commonly as broad as high. Of twenty-one species distinguished all but one are new.

D. P. P.

GEOLOGY.

Maryland Geological Survey. — The two handsome volumes, of which the second has quite recently been issued, representing the first publications of the Maryland Geological Survey,[1] under the direction of Prof. William Bullock Clark of Johns Hopkins University, are a credit to the Maryland Commission, and show clearly the advantage enjoyed by the Maryland geologists in their proximity to the offices of the federal Survey at Washington, and in their immediate association with the scholarship of Johns Hopkins University. A cursory examination of these volumes shows that the functions of a State Survey for the people of the state, in giving to them accurate information concerning maps, economic products, and topographic advantages, are distinct from those of the federal Survey, while at the same time it is very evident that coöperation with the United States Geological Survey is essential to such work. In the establishment of this Survey the legislature acted wisely in appointing the presidents of the two leading colleges members of the Commission; and the eleventh Resolution of the Commission, asking official coöperation from the head of the United States Geological Survey and from the directors of the geological surveys in neighboring states, has had much to do with the high grade of work shown by the Survey's first publication. For the execution of this work unstinted praise is due to Professor Clark and his assistant, Dr. Mathews.

In the first volume, "issued to set forth the organization of the Survey, and to show what has hitherto been done in the study of the geology, natural history, and resources of Maryland," the plan of operation of the Survey is stated concisely; a very complete statement of the physiography, geology, and mineral resources of Maryland has been compiled by Professor Clark, with a most scholarly historical sketch of earlier investigations. Dr. Mathews contributes a bibliography and cartography of Maryland, which is one of the most complete of its kind that we have seen. It is arranged in chronological order, and includes works from 1526 to 1896 inclusive,

[1] *Maryland Geological Survey*, vol. i (1897), 539 pp.; vol. ii (1898), 509 pp., plates and maps. Baltimore, The Johns Hopkins Press, 1897–98.

with a brief summary of each work. L. A. Bauer contributes a chapter on magnetic work, with a preliminary isogonic map of the state. In addition to the usual study of economic products, the plan of the Survey embraces a special investigation of road materials, of artesian well prospects, of water power, and of the physiographic features of the state. A geological map of the state, published in coöperation with the United States Survey, is incorporated in the volume, with also many photographic illustrations, a view of the topographic model of Maryland, index maps showing the progress of work of the United States Survey, and a hypsometric map.

The second volume is even more attractive than the first, the half-tone illustrations being supplemented by numerous photogravures on heavy paper, and colored plates showing the intimate structure of polished slabs of building stone which are, in the opinion of the reviewer, the most perfect reproductions of natural rock surface that have ever been made. Especially remarkable is Plate II, a granite porphyry from Ellicott City, in which even the cleavage fractures on the surface of the feldspar crystals and the semi-transparent appearance of the fracture edges are portrayed with perfect accuracy both as to color and form. After the administrative report of the superintendent, this volume contains a full account of Maryland building stones, by Dr. Mathews, with an introductory chapter on the physical, chemical, and economic properties of building stones, including methods of testing, by George P. Merrill. Dr. Mathews's work appears again in the third part of the report, in an exhaustive historical review of the maps and map-makers of Maryland. It is in these historical chapters that the first volumes of the Maryland Survey especially excel, and in them is shown the advantage of the extensive library facilities of Baltimore and Washington. Henry Gannett, of the United States Geological Survey, contributes a summary of the aims and methods of modern cartography, giving from his wide experience a systematic account of the object of the modern topographic map, the methods employed to-day in the government office, and figures and formulæ illustrating the use of instruments. This chapter by itself is of great value in giving to the public a statement of the latest methods of topographical surveying, with excellent photographic illustrations of the several instruments employed.

The second volume shows the success of the first efforts of the State Survey in impressing on the people of the state the value of its work, in that the General Assembly of 1898 passed special bills appropriating money for the extension of the topographic survey

and for the investigation of scientific methods of highway construction, following the lead, in this last respect, of the State of Massachusetts.

T. A. Jaggar, Jr.

PETROGRAPHY.

Granites and Diabases. — Milch's[1] article on the granitic rocks of the Riesengebirge and Bodmer-Beder's[2] paper on the olivin diabase from the Plessurgebirge in the Grisons are monographic presentations of the subjects they discuss. In the first, the author describes in great detail, and with a wealth of chemical analyses, the well-known granitite of the Riesengebirge, together with its basic and acid phases and the concretions they contain. Chemically, the rock is a mixture of Rosenbusch's granitic and dioritic magmas. The acid and basic phases are regarded as differentiation products of the magma that yielded the normal rock. Even the dike granites and the pegmatites of the district are looked upon as "Schlieren" in the granitic magma, formed by the solidification of the mother liquor left after the greater portion of the magma had crystallized. The basic phases of the rock often present the features of kersantites. They appear as concretions in the granitite and as dark "Schlieren" traversing it.

The diabases of the Plessurgebirge in the neighborhood of Chur occur as stocks, as horizontal sheets, and as dikes in the predominant limestone. In the center of the stocks its structure is granular; nearer the peripheries of the masses it is ophitic, and on the peripheries it is vitrophyric. Varioles and vacuoles are present as contact phenomena. The former are spherulites of radial plagioclase, and the latter amygdaloidal cavities that have been filled with albite, quartz, and calcite. The rocks present no unusual features, but the paper is worth examination because of its thoroughness in describing and picturing each structural form of the rock investigated and of its constituents.

Granitic Oceanic Islands and the Nature of Laterite. — The small group of tropical oceanic islands, known as the Seychelles, are noteworthy from the fact that they are neither of coral nor of volcanic origin, but are granitic in character. Bauer[3] reports that they consist principally of granites, and syenites cut by dikes and covered

[1] *Neues Jahrb. f. Min.*, Bd. xii, p. 115. [2] *Ibid.*, p. 238.
[3] *Neues Jahrb. f. Min.*, etc. Bd. ii (1898), p. 163.

in places by flows of felsite-porphyry, granite-porphyry, syenite-porphyry, hornblende-vogesite, diorites, diabase, and augite-porphyrite. The greatest interest of the paper lies in the discussion of the nature of the weathering product, laterite, which here, as in other tropical lands, constitutes so large a part of the rock covering. In the Seychelles this material results from the decomposition of both acid and basic rocks, but it is best developed in connection with the granite, bowlders of which may consist of the fresh rock in the center and laterite on the exterior, with a complete series of gradation forms between. The typical laterite is a red, brown, or yellow mass that may be dense and hard, clay-like, or sandy and friable under different conditions. Often this substance may be mixed with quartz grains or mica scales. In thin section it is sometimes nearly opaque, sometimes completely transparent. Everything but the quartz of the granites and the ilmenite of basic rocks has been changed to a light-colored, scaly aggregate of doubly refracting plates colored in places by iron oxides and other compounds. Analyses of this substance from granite and diorite yield: 60.68% Al_2O_3, 9.56% Fe_2O_3, and 29.76% H_2O for granite-laterite, and 51.98% Al_2O_3, 20.95% Fe_2O_3, and 27.07% H_2O for diorite-laterite.

Laterite is thus very different from clay; in composition it is much more like hydrargillite. The beauxite of the Vogelsberg and other supposed beauxites derived from basalts are of the same nature. In all cases the laterite is the residue left by leaching agents in a tropical climate. The occurrence of the beauxite at Vogelsberg indicates to the author the existence of a warm climate over this place at the time the beauxite was formed.

Isenite and Intermediate Types of Volcanic Rocks. — In the Westerwald, in the province of Hesse-Nassau, basalts, trachytes, andesites, and phonolites are well developed in many different phases, especially in the transition forms that have recently attracted so much attention among petrographers. The predominant andesite, for instance, is a transition phase between andesite and trachyte; some of the other andesites are basaltic in habit, and a few of the trachytes are phonolitic. Dannenberg[1] describes all these types in detail, and adds analyses of many of them. The "isenite" from Sengelberg, Kramberg, and Himmrich consists of a groundmass made up of lath-shaped plagioclases, and small grains of augite and of olivine, magnetite, and some secondary substances, and pheno-

[1] *Min. u. Petrog. Mitth.*, Bd. xvii, pp. 301, 421.

crysts of plagioclase, augite, and opacitic pseudomorphs of hornblende. The porphyritic plagioclase occupies about half the mass of the rock. Like the feldspar of the groundmass, it is a basic labradorite. The rock is thus a hornblende-andesite.

Dike Rocks of Portland, Me. — Lord[1] maps and briefly describes the basic and acid dikes that cut the schists in Casco Bay and on Point Elizabeth, Portland, Me. The basic dikes are nearly all porphyritic. In composition they are olivinitic and enstatitic diabases, and camptonites. The acid ones are pegmatites and aplites. The rock called camptonite is composed of porphyritic olivines and augites in a groundmass consisting of idiomorphic brown hornblende, anorthoclase, magnetite, and secondary products. The hornblende is in small prisms, some of which contain remnants of augite, and therefore are believed to be paramorphic. The anorthoclase is in lath-shaped crystals arranged radially. Analyses of the anorthoclase (I) and the camptonite (II) follow:

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	Na_2O	K_2O	H_2O	Total
I.	57.34		20.79	2.88		4.27	.16	8.09	4.17	2.66	= 100.36
II.	45.20	.68	17.12	5.98	6.55	7.89	5.29	4.23	2.13	5.53	= 100.60

In the course of his work the author separated the hornblende from the camptonite of Campton Falls, N. H., and subjected it to analysis with this result:

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	Na_2O	K_2O	Total
37.80	4.54	12.89	6.14	12.55	13.64	4.10	5.26	3.24	= 100.16

Notes. — A biotite-tinguaite dike cuts through the augite-syenite of Gales rocks, Manchester, Essex County, Mass. According to Eakle,[2] the structure of the rock differs from that of a typical tinguaite in that the feldspar and aegirine are in lath-shaped and prismatic crystals rather than in the acicular forms characteristic of this rock. In this respect it resembles sölvsbergite. The composition is:

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MuO	CaO	MgO	K_2O	Na_2O	H_2O at 110°	H_2O	Cl	Total
60.05	.11	19.97	4.32	1.04	.79	.91	.23	3.24	7.69	.15	1.26	.28	= 100.04

Oetling[3] has made a number of experiments to determine the effect of various conditions on the manner of crystallization of rock magmas, and has incorporated his results in an article full of interesting comments on his experimental methods and suggestions for future work on the subject.

[1] *Amer. Geol.*, vol. xxii, p. 335.
[2] *Amer. Journ. Sci.*, vol. vi (1898), p. 489.
[3] *Min. u. Petrog. Mitth.*, Bd. xvii, p. 331.

NEWS.

From the January number of the *Geographical Magazine* we learn that the Dutch government has placed at the disposal of the scientific men of Holland the newly built warship *Siboga*, of 820 tons, for the deep-sea exploration of the East India Archipelago. The vessel is fitted out with the Le Blanc sounding apparatus, a Lucas sounding machine, and an electric cable drum with a capacity of 10 kilometers of steel cable, and a zoological equipment for plankton, littoral, and deep-sea investigations, including deep-sea nets of the Chun, Tanner, and Fowler types. The cost of the expedition is met partly by the government and partly by learned societies and private individuals. The scientific leader of the expedition is Professor Max Weber, assisted by Dr. J. Versleys, Mr. H. Nierstrasz, and Dr. A. H. Schmidt. The object of the expedition is the zoological, botanical, and physical investigation of the marine area of the East Indian Archipelago, particularly of the deep basins of its eastern portion. The work of the expedition is expected to extend over two years.

The Macmillan Company has begun the publication of a new bi-monthly magazine, *Bird-Lore*, for observers of birds, under the above title. Mr. Frank M. Chapman is the editor of the paper, which is the official organ of the Audubon societies. Almost all the principal workers on birds out-of-doors will contribute during the year. Photographic reproductions of wild birds in their haunts will form a prominent feature.

The *Proceedings of the American Association for the Advancement of Science* has been issued this year with a promptness which is as gratifying as it is novel.

The German Anatomische Gesellschaft meets this year in Tübingen, May 22 to 25.

The Liverpool Museum is to have an addition measuring 162 by 190 feet, five stories in height. The three lower floors are for the technical schools, the two upper will afford galleries of horseshoe shape, the lower for invertebrates, the upper for vertebrates.

One cannot repress the feeling, as he looks over the reports of the various conferences on the bibliography of scientific literature, that

the committees are building an unwieldy machine with its central and regional bureaux.

The Boston Society of Natural History is trying to increase its membership. Reduction in the rate of interest of its invested funds threatens seriously to impair its usefulness unless the loss be made good in other ways.

Ever since his appointment as scientific director of the U. S. Fish Commission, Dr. H. C. Bumpus has been publishing notes on the breeding habits of animals at Woods Holl. It is to be hoped that the author will collect these notes, arrange them in systematic order, and reissue them as a whole, thus making them more useful to students.

The City Library Association of Springfield, Mass., will hold this month an exhibition of material relating to geography and geology, to show chiefly the results of geographical and geological research during the last few years. Methods of teaching geography and geology will form one of the chief features of the exhibition, which will also demonstrate, as far as possible, the progress of these sciences by the display of published results.

Professor A. S. Packard, of Brown University, sailed the first of the year for the Mediterranean. He will spend the winter in Egypt, Palestine, and other countries bordering on the Mediterranean, and later go to France to obtain materials for a proposed life of Lamarck.

The refusal of the leaders of the Geological Society of America to affiliate in any way with the other scientific societies which meet during the holidays may have some good reason behind it, but we have never heard of it. During the meetings of 1898 this isolation caused some complaint on the part of some of the geologists, for they were unable to obtain the reduced rates on the railroads which were enjoyed by the members of the other societies.

It seems probable that the Society of Naturalists, with its associated organizations of morphologists, botanists, anatomists, psychologists, etc., will meet in 1899 in New Haven.

The Paris Academy of Sciences has awarded half of the Lallemand prize to Mr. E. P. Allis for his memoir upon the head of Amia.

We chronicled some time ago the appointment of Dr. Slingerland as state entomologist of New York. It appears that there is a conflict in the laws as to the appointing power; this being given in one place to the governor, in another to the regents of the university.

We learn that Mr. Slingerland has no desire to enter into any contest for the position, and the appointment of Mr. E. P. Felt will probably hold. Cornell University is certainly to be congratulated in retaining the services of Dr. Slingerland.

The following persons have been elected to honorary membership in the Nebraska Academy of Sciences: Alexander Agassiz, LL.D.; John M. Coulter, LL.D.; Professor Samuel H. Scudder; Joseph Le Conte, LL.D.; Simon Newcomb, LL.D.; Dr. Otto Kunze; Professor Victor Hensen.

Professor O. C. Marsh, of Yale University, has recently been elected correspondent of the Academy of Sciences of Paris.

Appointments: Dr. John M. Clarke, state paleontologist of New York. — H. H. Dale, Coutts-Trotter student in zoology in Trinity College, Cambridge. — Wallace Craig, assistant in the Illinois state laboratory of natural history. — C. B. Crampton, of Edinburgh, assistant keeper of the geological department of the Manchester Museum. — Dr. Eugen Dubois, professor of geology in the University of Amsterdam. — Dr. E. P. Felt, state entomologist of New York. — Dr. Lepetet, professor of histology in the faculty of sciences at Clermont, France. — Dr. F. J. H. Merrill, state geologist of New York. — Dr. Heinrich Obersteiner, professor of physiology and pathology of the central nervous system in the University of Vienna. — Dr. Domenico Saccardo, assistant in the botanical gardens at Bologna. — M. Camille Sauvageau, professor of botany in the University of Dijon, France. — Mr. W. G. Savage, assistant in bacteriology in University College, London. — Giulio Valentia, of Perugia, professor of anatomy in the University of Bologna. — Dr. Weinschenk, privat docent in mineralogy and geology in the Munich Polytechnicum. — C. W. Young, assistant in botany in the University of Illinois. — Dr. K. W. Zimmermann, professor extraordinarius of anatomy in the University of Bern. — Dr. Oskar Zoth, professor of physiology in the University of Graz.

Deaths: Joseph Gibelli, professor of botany in the University of Turin. — M. Jacques Passé, assistant in the department of physiological psychology in Paris. — James Spencer, geologist and paleobotanist, July 9, at Akroydon. — Dr. G. Venturi, Austrian bryologist, June 5.

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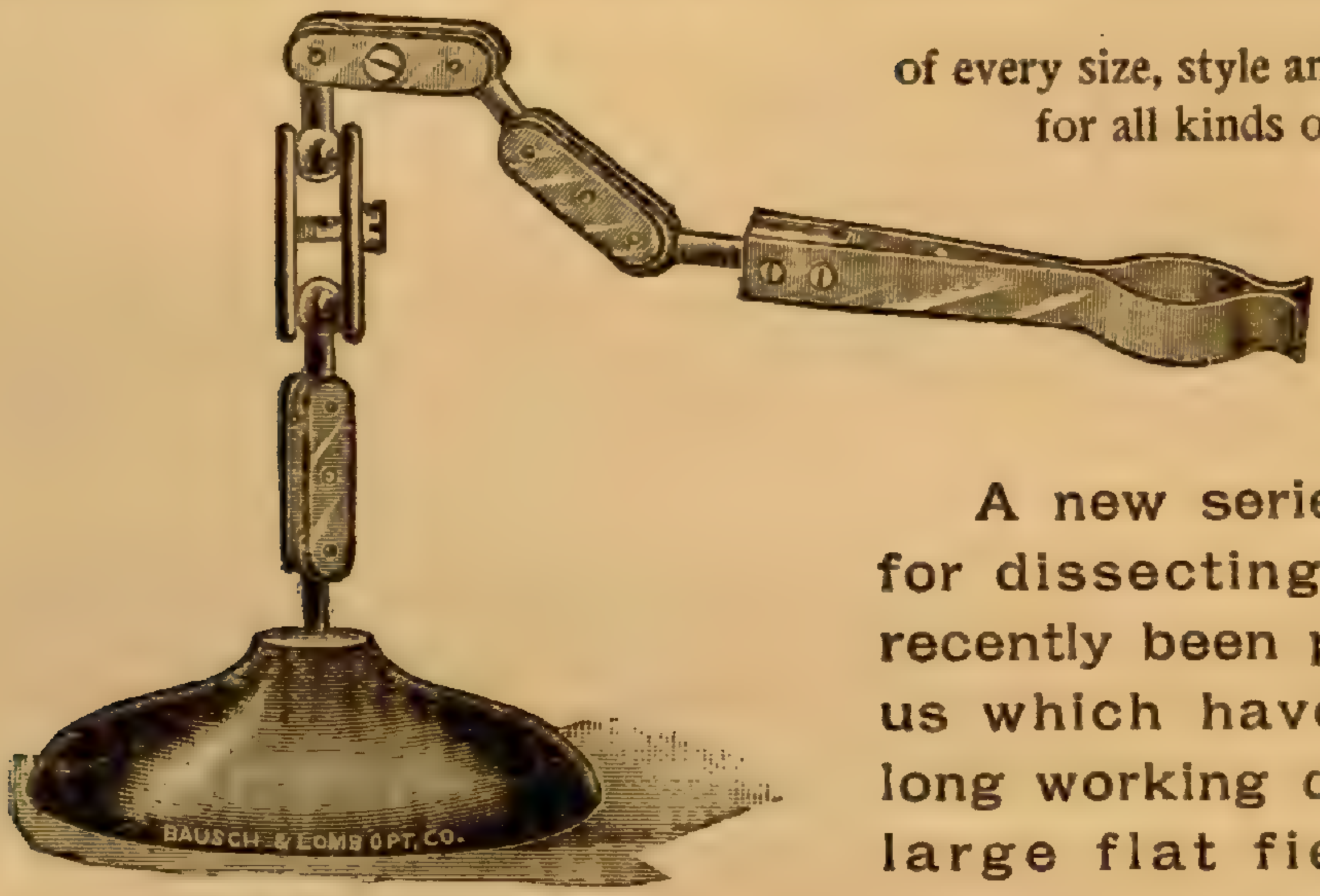

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DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE

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FOUR CATEGORIES OF SPECIES.

O. F. COOK.

There are at least four different sorts of species, so called, involved in the study of as many theoretically related, but also theoretically and practically distinct, taxonomic problems. The result of indiscriminately confusing these problems and their specific criteria has been the occasion of many destructive criticisms of systematic biology. Such objections are frequently valid, but not as uniformly pertinent, since they rest, in reality, on faulty analysis rather than upon any inextricable difficulties or logical inconsistencies connected with the several tasks of biological taxonomy.

To vary somewhat the familiar comparison of organic nature to a tree and its branches, evolutionary theories permit us to think of life rather as originating at a point which, by the accretion of countless successive individuals, has become the center of a sphere upon whose surface existing vitality appears as islands in the sea of nonexistence. The section of such a sphere would differ from that of the earth in that the oceans would have enormous depth, for the solid core would separate from near its center into numerous and repeated divisions.

It is perhaps conceivable that life might have reached variety and complexity without accompanying segregation into limited

groups of similar individuals, in which case all the circumferential possibilities of form and structure would have been realized, with a result comparable to a uniformly solid sphere. Arguments and phylogenies are often based on this assumption, that all organic types have been connected by intermediate forms; but there is no valid reason to suppose that more than very few of such theoretical possibilities have been projected into the actual; the oceans of our vital globe are not only deep, but are in overwhelming proportion to the space otherwise occupied. Segregation has everywhere accompanied differentiation in structure, and the forms which might have maintained connection between the various branches of life are not in most cases to be thought of as extinct; they have never come to expression, never existed.

Having been accustomed to consider organic types as forming connected series, those who have approached systematic biology from the paleontologic standpoint have been especially prone to overlook the distinctions which arise from the fact that all such series are, in fact, lineal, and that their successive members have always been separated by chasms of nonexistence, so to speak, from all except phylogenetically related forms. Moreover, the points of actual contact with these last are few and momentary if the extent of biological history be taken into account; a grave fallacy is accordingly involved in the theory of classification which attempts to render nature at large comprehensible through methods logically applicable only to phylogenetic series. From the practical standpoint it is as though topographic expedients were limited to the numbering of houses. As such designations are of no utility unless streets are also known, so is the lineal method of classification of use only in dealing with ascertained series. Notwithstanding the theories of interlacing phylogeny which some authors have propounded, it may be asserted with confidence that the analogy of streets and numbers has but a limited application in nature. There are no cross-thoroughfares; all the lines radiate in general from a center, and while they may sometimes become closely parallel, we have as yet no adequate evidence that under natural conditions they ever reunite after more than the briefest divergence.

The species of the paleontologist is, then, with reference to the other members of its line, an arbitrary division of a continuous series of gradually changing forms. The fact of established sequence will go far to prevent confusion, and the purposes of classification are served by such a knowledge of forms and characters as will make possible the reference of a given individual to its proper place in the series. Illogical procedure may be charged against any attempt at applying these concepts or methods outside of the lines of established, or at least suspected, phylogeny.

The termini of such of the paleontological series as have not become extinct are the subject-matter of the biology of to-day, in contradistinction to that of the past or the future. Returning to the former analogy, it may be insisted that as the accretions of the life of previous ages have been built up on distinct lines, so is existing life manifested in assemblages of similar individuals, which are obviously distinct collectively. The forms which would be required to connect them do not exist, and we shall make little true progress in the knowledge of organic nature until we abandon the attempt at arranging living organisms in continuous series. With rare exceptions their relationship must be traced through the more or less remote past. In one sense all life may be thus connected, and absolute lines between groups of specific or higher rank are forever impossible; but in another and equally important sense groups of living organisms may be looked upon as separate and independent, though collective, entities. The study of geography has not been abandoned because of the discovery that all land is connected by the ocean bottom, nor is the topography of a series of islands neglected because soundings prove that they are peaks of a submerged mountain range. No naturalist denies the existence of clearly defined and easily recognizable specific groups, but the difficulty experienced in attempting to resolve the more nebulous parts of nature has sometimes blurred the eyesight of the systematist. In some generic archipelagoes the specific islands stand out prominent and distinct, like the members of the Canary and Hawaiian groups; while in others they are painfully similar and are separated only by narrow,

shallow, and tortuous channels, like the Florida Keys. These last are, indeed, a cartographer's nightmare comparable to the species of *Aster* and *Sphagnum.* But whether the naturalist's theories help or hinder, his descriptive task will not be complete until the facts of nature have been recognized and recorded, until all the islands have been located and mapped. That this work is in a confused and backward state is partly due to the conceptual fallacy of species and genera, which has led us to attempt to map the islands without securely locating them by the designation and preservation of types.

To divide a continuous series of forms into "genera" and "species" is a thoroughly artificial process analogous to the marking of feet and inches on a measuring rod, and is one of the instances where the naturalist may be said to "make" the "species." The specific islands of living organisms are, however, not made, but discovered by the systematist, and located, not primarily with regard to their disposition in an ancestral series, but with reference to other separate groups. Whether a specific island is large or small, circular or irregular in shape, is not subject to our determination; and the naturalist who expects to apply throughout nature a general concept of species based on the "size" or "weight" of characters is about as well equipped for his work as a map-maker who should undertake to draw a chart of the Florida Keys without other tools than a circular die. With such an implement he could in a general way indicate the location of a few well-separated islands like the Canaries, but the other task is practically impossible.

Although chronologically the first, the problem of systematic paleontology, on account of the fragmentary nature of its material, must depend largely upon the results gained in the study of existing forms. Isolated fossils may be classified, for the sake of convenience, in so-called species and genera in a manner analogous to that used with living types; but when any approximation to a complete phylogenetic series can be made out, that method is no longer logically applicable. The chasms which separate species in the present do not interrupt the unbroken line of ancestry which stands below every existing type,

and to locate a particular point in a continuous series of this kind is manifestly a different problem from that of finding the island which is its extremity. The necessities of the first case are met by observing the appearance, development, and perhaps the decline of some important structure, such as a tooth. The line of natural succession is the important fact, and the classification, as far as there is any, is here of necessity artificial, touching at only one point, that of living forms, which lies in a distinct plane. It is only when considered with reference to their own horizons that fossil species are distinctly comparable to the specific islands of to-day; and to fail to consider the breaks in the horizontal series, because the vertical series is theoretically continuous, is one of the more important instances where a confusing element has been unnecessarily and illogically introduced. It is one task of taxonomy to recognize the facts of the present; and this need not be complicated, but should rather be assisted, by a knowledge of what has been or a suspicion of what may yet be. Nor is it necessary to be frightened by the captious warning that the species now existing will give place to something different to-morrow. The "now" is at least sufficiently extensive for our purposes. As to the coming change, posterity will not know its rate nor direction unless we certify the details of the present reality. The careful description and preservation of types, instead of works of supererogation, are of the utmost importance, not as means of specific limitation, but as giving fixed points about which accretions of knowledge may gather. The recognition and adequate designation of natural species or higher groups are frequently matters of extreme difficulty, requiring extended and careful study which the agnostic naturalist jauntily avoids, sometimes by professing interest in "more important" problems. To tell from a few specimens whether a new form represents a distinct species or not is frequently impossible, and opinion must be provisionally based on the analogy of better known relatives; but this initial difficulty in no way affects the practicability of the subsequent settlement of the question by more extended observation.

Whether the segregation of a new group has been accom-

plished seems to be a matter of indifference to some ultra-progressive naturalists. It is as though a geographer, having learned that a certain region is slowly subsiding, should proceed to name the hills as islands, and publish his book revised for the next geologic period. Such a procedure would be, to say the least, misleading, both for the present and future generations. This is the third type of "species," very much in evidence at the present day. Although the designation by name of the various prominences or arms of a diversified island is desirable, even before the expected separation occurs, the prophetic tendency should, in the interest of historical accuracy, be curbed to the extent of distinguishing in category between groups which are already segregated in nature and those which are not. One naturalist refers to an entire island as a species, while another divides it into numerous parts which he still calls "species." Now these parts may be as abundant in individuals, and their extremes may show differences even greater than those separating completely isolated species, but by treating them as already distinct we ignore the existence of intermediate forms and proceed as though degree of apparent difference were an index of segregation or a taxonomic substitute for it. The theory that the formation of species through differentiation and segregation is proceeding continuously throughout nature has too often served as a warrant for a complete confusion of issues, with the natural result that some writers have shown more frankness than perspicacity in assuming the position that species are among the things "past finding out."

As if to solidify the confusion and justify this attitude, the naturalist is called to deal with a rapidly increasing number of man-made perversions, or at least diversions of nature. We assemble from different continents species of undoubted distinctness and absolute segregation in nature, and produce hybrids which nature would never have formed and would not now permit to exist except under human auspices. Some natural species, too, have shown themselves wonderfully susceptible of change through the influence of selection, so that the honest advocate of a general specific concept finds himself under the

necessity of recognizing species and genera created by the gardener and poultry fancier. Taking as a criterion of amount the minute differences by which some distinctly segregated species, such as those of *Antennaria*, are distinguished, the impartial botanist of conceptual proclivities would find himself more than occupied in providing for the scientific recognition of horticultural novelties. With degree of difference as the criterion of classification, the annual increase in the species of the genus *Rosa* would be very considerable, for the divergences resulting from crosses and selection are often as great as those existing between wild species of undoubted validity.

The four types of species may then be enumerated as follows:

1. *The phylogenetic species, a division or section of a line of biological succession.*

2. *The insular or segregated species, the living end of a line of the preceding category.*

3. *The incipient species, preferably known as the subspecies*, which is a subdivision of the second category, being a group of individuals showing distinctive characters and a tendency to segregation, but still connected with other groups by normally existing intermediate forms.

4. *The artificial species, the result of man's interference in nature*, by which the specific islands of the second category have been, as it were, remodeled or connected by causeways or bridges, the natural tendency to isolation and segregation having been reversed through human agency.

In one case only does nature limit the species; in the other three the species are arbitrary in the sense that their boundaries are formal and to that extent conceptual. It were much better if other terms could be made available, so that the designation "species" might be reserved for its original use with the second category. For the third the appropriate term "subspecies" is increasing in favor, while to the fourth there seems to be no good reason why the popular designation "variety" should not be restricted. Even here it is not the absolute degree or amount of difference which determines the desirability of independent recognition for a new form, but the constancy and utility of the differences. It is fortunately still true that

the second category stands forth as by far the most important sense of the term "species," and much confusion and difficulty would have been avoided if it had been consistently restricted to that purpose. But equally loose has been the application of the subordinate designations "subspecies," "variety," "form," and "race." With "amount of difference" as the only criterion, fossils, geographic races, and artificially produced varieties are being catalogued miscellaneously and indiscriminately as "species."

After this failure to distinguish between the different tasks of taxonomy, it is not surprising that the total difficulties have been set forth with as complete an absence of discrimination. It is true, for instance, that some so-called species are arbitrary and artificial concepts, though it is equally true that other species are clearly defined assemblages of similar individuals, the case depending on how we make our terms and how we use them. But it is least certain that any method of procedure is faulty which tends to obscure the various issues and make confusion where none need exist. The limitations of our ignorance are already great enough without unnecessarily increasing them. A student of geography might conclude, after spending some time on the attempt, that it would not be worth while for him to write a monograph of the Florida Keys, but we would scarcely expect him to advertise his failure by composing a treatise to show that geography is an impossibility, since coast lines and landmarks are continually changing. The facts of nature are what we are trying to learn, not systems and concepts. These are, at best, but means, and we should change or throw them aside if they fail of their purpose, instead of allowing ourselves to become entangled in them. Let the term "species" be abandoned altogether, if by so doing we can better realize that the tasks of biological taxonomy are not one, but several, and that each should be approached to the greatest possible advantage without being gratuitously complicated. To trace lines of descent and be able to locate each individual in its proper place is a work quite distinct in plan and execution from the mapping of the islands of life as they lie in the sea of nonexistence. The topography of individual islands is

a subject of extreme interest, and it is perhaps even more important to record and make accessible all knowledge gained regarding the behavior of organized nature under the moulding hand of men. Many facts will have places in the treatment of all four problems, since these touch at many points; but from the standpoint of the execution of the work there is no logical necessity that any one task be rendered more difficult by the existence of the others. In dealing with each of the categories here enumerated, appropriate criteria of so-called species should be sought and persistently followed. If we are to continue to talk of geological or phylogenetic species, we must understand that they can, even in theory, be little more than arbitrary sections of the extinct lines of succession leading up to the living islands of the present, of which the number, form, and relative position can be satisfactorily determined only by directing attention to the question of segregation by space, time, or mutual sterility. To certify on simple inspection whether an individual specimen of a previously unknown plant represents a new species, a subspecies, or a hybrid, is, and must remain, impossible. Notwithstanding much eminent opinion to the contrary, we may insist that the facts of nature and not the concepts of the human mind are the primary objects of biologic study. In this instance, at least, we may rest assured that no refinement of concepts will enable us to know in advance facts which must be ascertained by careful and often by extended observation. The believers in the doctrine of "amount of difference" have, it is true, an apparent advantage in that by the simple application of their individual measuring rods they may be ready to assert, without the embarrassment of delay, that a new individual represents a new species, since it appears "sufficiently different" from others to meet the demands of their "conception of species." If these mental phenomena could be communicated with uniformity to other naturalists, the method would have a practical advantage which it does not now enjoy, since the conception is merely individual, and uniformity of opinion can never be expected. Segregation or its absence is, however, a fact of nature which may be established by careful observation, like other phenomena. If some systematists deny

this, they are but confessing that species are for them descriptions in books, not aggregates of similar individuals in nature. From the biological standpoint there could scarcely be more useless and unproductive labor than this of matching descriptions. The merits of a proposed species, that is, its normal segregation in nature, are not to be inferred from the formal description of a few individuals, and all so-called "species" established on such a basis are merely tentative propositions — suggestions for study. The question is not whether the description is different from all other descriptions, but whether the type specimen is, in reality, a member of an independent series of individuals, a distinct branch of life, a separate island of existence. The systematist is in no way responsible for the conditions; it is his business merely to recognize and record them. The difficulties vary greatly in different parts of nature, depending upon facts in the biology of the various groups. Thus the well-nigh inextricable confusion of the genus *Sphagnum* is undoubtedly connected with the fact that all the species have almost exactly the same position in the economy of nature, and affect the same habitat, while segregation has been further hindered or at least obscured by the absence of any natural period to the life of the individual plants. Remotely ancestral and all succeeding forms may still exist simultaneously and contiguously, affording a rare complication of difficulties. But in this case, as in others, we can best gain knowledge of the lines of divergence and learn something of the present tendencies of evolution by locating the breaks in the series of forms. The use of the term "species" may be a matter of indifference, but confusion in this formal regard should not be allowed to obscure the interest which attaches to the history and status of so isolated a group of plants.

Having once located and delimited our specific islands, the work of studying their internal topography is comparatively simple. The limitation of subspecific groups is necessarily arbitrary, but it need not be on that account artificial, the object of such subdivision being the recognition of tendencies toward segregation, rather than the formation of groups of uniform size. We are concerned, in other words, with the natural

features of our islands rather than with the number of farms or building lots into which they may be subdivided.

The fourth type of species may not appear logically distinct from the second and third, since natural hybrids occur, and have had, no doubt, their influence in evolution. From the practical standpoint, however, it may be maintained that the hybrid nature of a new form is not to be assumed without reason; and it is plain, in addition, that where we know the history and ancestry of a hybrid or selective variety, we should draw every possible advantage from that knowledge instead of undertaking the gratuitous labor of attempting a second and entirely artificial diagnosis. With domestic animals classification is carried to its ultimate extreme by means of carefully recorded pedigrees, while in the cultivated plants a similar refinement exists, particularly in the varieties of fruits which are propagated by grafting, the so-called variety being, in a sense, but a single individual, in spite of its extensive multiplication and distribution. Such classifications are not less scientific because they are also of practical utility, and the necessity of uniformity in the nomenclature of artificial varieties and hybrids is becoming a scientific as well as a popular necessity. At the same time it is extremely doubtful whether the desultory systematic methods of the past and present can supply such a desideratum. Any attempt at instituting an authoritative nomenclature of cultivated plants would need, in justice to the practical interests concerned, to be so equipped as to furnish prompt and accurate determinations, and to be able to incorporate into knowledge and provide names for all new varieties without loss of time. Such a plan once carried into execution would be of the greatest importance to agriculture, since it would render practicable the execution of laws which might be enacted to prevent the present enormous losses from falsely named and dishonestly advertised seeds and propagating stock.

VACATION NOTES.

DOUGLAS HOUGHTON CAMPBELL.

I. Notes on the Californian Flora.

During the past summer my vacation was spent in visiting various parts of the Pacific Coast, my travels extending as far north as Skagway. While it must be admitted that the various trips made were intended primarily for recreation, rather than for scientific purposes, still a botanist could not fail to be deeply interested in the rich and striking flora of our western possessions, and I have tried here to jot down some of the impressions made upon me in my wanderings over this most picturesque part of our country.

It is hardly necessary to remind the botanist how very marked are the differences between the floras of the Atlantic and Pacific regions of the United States, especially in the more southern parts. The topography of the Pacific slope, with the lofty Sierra extending practically without a break from Alaska to Mexico, produces climatic conditions very different from those of the Atlantic States. The differences in climate, together with other factors affecting the origin and distribution of the western plants, have resulted in a flora which makes most of California seem very unfamiliar to the eastern botanist.

The Santa Clara Valley, in which Stanford University is situated, is thoroughly representative of middle California. This is the great fruit region of the state, and the level floor of the valley and lower foothills are largely given up to orchards of prunes, apricots, and peaches, while extensive vineyards are also planted, and large quantities of wine are made in some sections of the valley.

The valley opens at the north upon a long extension of San Francisco Bay, and here the extreme width of the valley is perhaps fifteen miles, narrowing rapidly as we go south. To

the east lies the Mt. Hamilton or inner coast range, with Mt. Hamilton, some 4500 feet above sea level, as its highest point. To the west rise the densely wooded Santa Cruz mountains, somewhat lower than the eastern range, and separating the valley from the ocean.

The floor of the valley and the rolling foothills are covered with spreading oaks, which in places form extensive groves, which can hardly be dignified with the name of forests. The scattered groups of oaks give a park-like aspect to the landscape which is most attractive. The prevailing species are the live oak (*Quercus agrifolia*) and the white oak (*Q. lobata*). Along the water-courses and roadsides there is a dense growth of shrubs, the remains of the "chaparral" or thickets which originally covered much of the valley. The chaparral is composed of a variety of shrubs and small trees, among which may be mentioned the Californian buckeye (*Æsculus californica*), Bigelovia, *Rhamnus californicus*, poison oak (*Rhus diversiloba*), toyon (*Heteromeles arbutifolia*), and elder (*Sambucus glauca*), the latter a very characteristic species with glaucous berries, and forming a small tree of 15 to 20 feet in height.

Along the water-courses and in the moist canyons leading into the valley are various trees, but none of very large size. Besides the species of willows and poplars, alders, becoming trees 50 to 60 feet high, are common; and with these are a number of trees less familiar to the eastern botanist. The beautiful bay tree (*Umbellularia californica*) is abundant, and the equally striking Madrõno (*Arbutus menziesii*), with its smooth cinnamon-red branches and magnolia-like evergreen leaves, is decidedly novel in appearance. The Oregon maple (*Acer macrophyllum*) is also a conspicuous tree of this region. An occasional redwood (*Sequoia sempervirens*) is sometimes found along the banks of the streams several miles away from the base of the mountains, but it is in the sheltered canyons higher up that this monarch of the coast ranges reaches its full development.

The common flowers of the valley are the characteristic ones of the central Californian region, and are, for the most part, of southern origin. Many leguminous plants, especially pecul-

iar species of Trifolium, Lupinus, and Hosackia, abound; and early in the spring the grassy meadows and hillsides are often covered with masses of these flowers as well as many others. Species of Nemophila and Phacelia represent the Hydrophyllaceæ, while the Borraginaceæ include species of Amsinckia and Erytrichium, which, although the flowers are small, occur in immense quantities, and are thus very conspicuous. Unfamiliar Scrophulariaceæ, like Orthocarpus, Mimulus, and Collinsia, and the showy poppies, Eschscholtzia, Mecanopsis, and Platystemon, are all very different from their eastern relatives. Many beautiful liliaceous plants also occur in great profusion. The most striking of these belong to the western genera Calochortus — the beautiful Mariposa lilies — and Brodiæa; while higher up among the redwoods are the more northern genera, Fritillaria, Erythronium, and Trillium. In the open sunny valleys these vividly colored flowers often occur in great masses, and form veritable carpets of bloom that it would be hard to equal anywhere.

Later in the season appear hosts of low-growing Compositæ, and on the barren hillsides we may look for the showy Onagraceæ, so abundant in Pacific North America. Besides the familiar Epilobium and Œnothera, there abound species of Godetia and Clarkia, and late in the summer the scarlet fuchsia-like Zauschneria.

With the cessation of the rains, which may occur any time after the first of April, the flowers mostly disappear, and the hillsides assume their summer dress of golden brown until the autumn rains start the seeds into growth again.

Last year was an exceptionally dry one, and when I left San Francisco, about the first of June, the surrounding country was already dry and dusty, and scarcely a trace of the spring verdure could be seen anywhere.

I had engaged passage for Sitka from Tacoma on June 19, but decided to spend the interval at some point in Northern California, which, except for such glimpses as one can get passing through on the railroad, was a new country to me. My destination was Castle Crag, one of the many charming spots in the beautiful mountain region of the north. It lies about 2000 feet above sea level within twenty miles of the base of

Shasta, the most beautiful, if not the highest, of the mountains of California. The view of the glorious snow-covered peak, over 14,000 feet high, is one never to be forgotten. The great pyramid rises from a vast plain, with nothing to break the long, smooth sweep of the slopes of its symmetrical cone. Seen from Castle Crag, the mountain is peculiarly impressive, and its snowy cone, framed by giant pines, is a sight, once seen, to be remembered for a lifetime.

The general aspect of the country about Castle Crag is very different from that of the more southern valley regions. Here the railroad follows the narrow gorge of the upper Sacramento, and on each side the steep, heavily forested mountains rise, the only level ground being little meadows nestled between the bases of the hills or forming a narrow margin to the streams. The rains had not yet ceased, and the vegetation was in the full luxuriance of early summer — a sharp contrast to the dusty sunburned aspect of the lower valleys.

The magnificent forest here has been carefully protected, and gives one a good idea of the character of the virgin forest of the northern mountains. The prevailing trees are the sugar pine (*Pinus lambertiana*), yellow pine (*P. ponderosa*), white fir (*Abies sp.*?), and Douglas spruce (*Pseudotsuga douglasii*). In the low ground near the streams the yew (*Taxus brevifolia*) was not uncommon, but this does not, in this region at least, form a tree of any size. Along the streams, and forming an undergrowth in the lower forest region, are numerous deciduous trees and shrubs, most of them northern types, and often nearly related to eastern species.

None of the deciduous trees attain a large size, but further north some of them, like the big-leaved maple (*Acer macrophyllum*) and ash (*Fraxinus oregana*), become valuable timber trees. Alders and willows along the streams, and several oaks, the pretty vine-leaved maple (*Acer circinnatum*), and flowering dogwood, are the commonest constituents of the arborescent undergrowth. With these are mingled many fine flowering shrubs which add much to the beauty of the forest. The dogwood (*Cornus nuttallii*), which is said to be even more beautiful than the eastern species, was nearly past, but to judge from the

remains of the large inflorescences, which much exceed in size those of *C. florida*, this may well be true. By far the most beautiful of the flowering shrubs, at the time of my visit, was the exquisite azalea (*Rhododendron occidentale*), which formed extensive thickets covered with masses of the lovely pink and white fragrant flowers. It is not unlike *R. viscosum*, but is much finer than that species. Calycanthus and Philadelphus were seen along the railroad, but were not noted in the immediate neighborhood. Wild roses were abundant, and the thimbleberry (*Rubus nutkanus*), with its big maple leaves and showy white flowers, was very common, as it is throughout the whole of Pacific North America, from the mountains of middle California to Alaska, and east to Lake Superior, where I remember to have seen it for the first time many years ago.

The abundant moisture of the lower forests and the numerous streams at their bases are favorable to the development of a rich herbaceous flora, among which we find many beautiful flowers. The spring flowers, like the Fritillarias and Erythroniums, and the early violets, were gone, but the early summer flowers were abundant. Most of these belonged to familiar genera, and the species were not infrequently allied to eastern ones. *Dicentra formosa*, much like the eastern *D. eximia*, was very common, and *Aquilegia truncata*, differing but little from *A. canadensis*, was frequent. Carpeting the floor of the forest were two or three species of Asarum, one with beautifully reticulated leaves, and several species of Pyrola, among them the curious *P. aphylla*, were common. Above the thickets of brakes in the low ground, the gay flowers of *Lilium pardalinum* were to be seen, recalling the brighter forms of *L. superbum*.

Orchids, which are rare in California, were represented by several striking species. Two Cypripediums, *C. montanum*, much like a white-lipped *C. pubescens*, and *C. californicum*, with smaller flowers, were met with, but both are rare plants. A Habenaria with inconspicuous flowers, and the very striking and peculiar *Cephalanthera oregana* were the two commonest orchids. The latter was frequent in the shady woods, where its ivory-white stems and flowers, the latter with a touch of yellow on the lip, were very conspicuous.

Everywhere along the streams were clumps of the giant peltate leaves of *Saxifraga peltata*, one of the most striking plants of the Californian mountains.

The natural meadows are a marked feature of this region. The absence of protracted drought permits the growth of perennial grasses and other meadow plants. White and red clover have become naturalized, and various Compositæ, like Rudbeckia and Erigeron, mixed with these, gave the meadows a very familiar aspect, although purple and white Brodiæas and some other western plants were mingled with them.

Perhaps the most interesting plant met with near Castle Crag was the curious Darlingtonia — the Californian pitcher plant, which I saw growing for the first time. It occurs abundantly at several points near Castle Crag, but we found it in greatest perfection on a steep hillside sloping to the Sacramento. There are no peat bogs in this region such as harbor our eastern Sarracenias, but the plants were growing in the boggy ground made by the damming of a little stream which flowed down the hillside into the river. Here in the bed of the brook were growing dense clumps of the tall light-green trumpets of the Darlingtonia. Some of these were quite two feet in height, and their vivid apple-green hoods were extremely conspicuous. Here and there the greenish-yellow Sarracenia-like flowers nodded on tall stalks above the leaves, or were replaced by the oval green seed-vessels. Darlingtonia recalls the tall southern species of Sarracenia like *S. variolaris*, with which it agrees in the presence of the translucent spots in the hood, as well as the form of the pitcher. It is much less like *S. purpurea*, which is its nearest neighbor among the Sarracenias. It would be interesting to know how this curious plant has become stranded high up in the Sierra Nevada, so far away from its eastern relations.

While ferns were numerous in some localities, the number of species was not great, nor were mosses as abundant as might have been expected. Aside from the ubiquitous *Pteris aquilina*, the most noticeable ferns were *Adiantum pedatum* and *Woodwardia radicans*, both of which attain great perfection on the shady hillsides, although neither can be said to be very common.

In the moist thickets and meadows, four species of Equisetum were noted — all, so far as I know, that have yet been noted for the state, except *E. hiemale*, whose occurrence here is doubtful. The two large species of the region of San Francisco, *E. robustum* and *E. maximum*, were abundant, and *E. arvense* and *E. lævigatum*, which are apparently confined to the mountain districts, were not uncommon.

Two points in the neighborhood, the granite crags, from which it takes its name, and Cragview Summit, each about 6000 feet above sea level, are easily reached, and their upper regions, which are much more arid than the lower forest, have a very different flora. As we ascend, the dense undergrowth of deciduous shrubs disappears, and the floor of the forest is but scantily covered with vegetation. On the exposed summits the trees either disappear or are much stunted, although the true timber line is considerably higher in more sheltered situations.

On the dry hill slopes there is the usual growth of chaparral, made up largely of species of Ceanothus, one of which (*C. thyrsiflorus*), was covered with heavy-scented blue flowers, known popularly as "California lilac." The densely matted thorny stems of the Ceanothus make at times an almost impassable thicket. In the higher regions several evergreen shrubs formed part of the chaparral. Of these the most conspicuous were the dwarf chestnut (Castanopsis) and manzanita (Arctostaphylos).

Many beautiful flowers grow in these dry regions. Chief of these is the beautiful white lily (*Lilium washingtonianum*), known locally as the Shasta lily. It is very common, and its straight stem and regular whorls of undulate leaves were seen on all sides rising above the low chaparral. Most of them were in bud, but only a few were seen in flower, as they are not in full bloom before the end of June. This beautiful lily is quite different from any of our eastern species, and the form of the flower, as well as the odor, recall the magnificent Japanese *L. auratum*, although the flowers are very much smaller.

Other showy flowers noted were the scarlet *Delphinium nudicaule*, *Iris macrosiphon*, *Calochortus maweanus*, species of Castilleia, Godetia, Pentstemon, and the curious *Spraguea umbellata*, a characteristic plant of the higher Sierra. *Symphoricarpus sp.?*

and *Smilacina amplexicaulis*, much like *S. racemosa*, were also noticed, and in places, *Veratrum californicum*, with its great plaited leaves, was very conspicuous.

A second trip was made later in the summer to the higher Sierra of central California. My destination was Lake Tahoe, that beautiful mountain lake lying over 6000 feet above the sea, on the boundary between California and Nevada. It lies on the eastern slope of the mountains, and the surrounding country is much more arid than the western slope of the Sierra. The lake is very deep — over 1600 feet in places — and the waters are marvelously clear and of an intense sapphire blue, such as I have never seen elsewhere except in tropical seas. Very little vegetation exists in the lake itself, and only in a few places are the shores at all marshy.

The past summer was an exceptionally dry one, and I must confess to a feeling of disappointment in the flora of the surrounding country, which was nearly everywhere dry and dusty.

Where the shores of the lake have been undisturbed there is a good growth of trees, some of quite large size. Some of the yellow pines were about 150 feet high and five feet in diameter, but the trees do not attain the dimensions of those in the great forest belt on the western slopes of the mountains. In most places the timber has been cut, and the shores present a miserable appearance. Besides the yellow pine, there is some sugar pine and tamarack (*Pinus contorta*, var. *murryana*), and the incense cedar (Libocedrus) and several firs are also not uncommon.

The growing season is very short, and the trees must grow very slowly, to judge from stumps which were examined. This is especially true of the cedars. A stump, perhaps five feet in diameter, showed over 700 growth rings, and doubtless some of the largest trees were at least 1000 years old. The pines grow much more rapidly, none of the yellow pines examined being over 300 years old.

Among the trees there is little undergrowth, but the exposed places and the hillsides are covered with an impenetrable thicket of Ceanothus, manzanita, and dwarf chestnut, with a sprinkling of other shrubs.

The most beautiful part of the lake is the southern end, where there are extensive meadows and apparently more moisture than in the other parts of the shore. Here also are the highest mountains, rising from 4000 to 5000 feet above the lake. Here were found the only marshes seen about the lake. At one point a small stream enters the lake, flowing through level meadows and forming small marshes in which a number of interesting aquatic plants were observed. These included a number of interesting algæ, as well as Utricularia, Potomogeton, Nuphar, Sparganium, and others not noted elsewhere.

In ordinary years it is said that snow lies on several of the peaks for most of the summer, but last year, in August, there were merely a few small patches on Mt. Tallac, the most accessible of the higher peaks.

My first stopping-place was at "McKinney's," on the west shore of the lake, and from here a number of excursions were made in various directions. The shores of the lake at this point are low, and the forest comes down to the water's edge. As we have already indicated, the forest is composed entirely of Conifers, but along the streams, and in a few places on the hillsides, are small groves of willows, alders, and poplars which, however, are never of large size. The sandy soil between the trees was covered in spots with low-spreading mats of Ceanothus and Arctostaphylos, but was often quite bare. Flowers were scarce, but there were a few showy ones, the most striking being a brilliant blue Pentstemon, scarlet Castilleicas, two or three Gilias with scarlet and flesh-colored flowers, and the big sunflower-like Wyethias.

In the shelter of the denser woods, away from the lake, were other plants which needed more shade. A dwarf form of *Rubus nutkanus* was common, and species of Pyrola and Chimaphila, as well as two orchids, *Goodyera menziesii* and *Corallorhiza sp.?* were found here. At a number of places the withered remains of the curious snow-plant (*Sarcodes sanguinea*) were seen, but its season was past.

At the extreme southern end and on the western shore, the shores become more arid, and the growth of trees is scattering. The open ground and the lower hills are covered with sage-

brush and other plants characteristic of the Nevada deserts, and the vegetation is thus intermediate to some extent between the desert flora of the Great Basin and the mountain flora of the Sierra Nevada.

The higher altitudes show a more or less pronounced alpine flora, which was seen to best advantage when making the ascent of Mt. Tallac, whose summit is nearly 10,000 feet above sea level. At the wind-swept summit the characteristic alpine white pine (*Pinus albicaulis*) at once attracted attention. The gnarled trunk, with smooth light-gray bark, and the twisted branches were beaten flat upon the ground in the more exposed situations. This well-marked species is one of the most striking of the numerous Conifers of the Sierra. A little lower down a juniper — probably *J. occidentalis* — was noticed, a tree of perhaps 30 to 40 feet in height, with massive trunk and branches. In sheltered hollows near the summit, beds of arnica were blooming, and among the flowers were swarms of bees and butterflies which had been attracted to these high altitudes. Of the flowers encountered on the way up, the most striking was a beautiful blue gentian, probably *G. calycosa*. Other plants noted were *Aconitum Fischeri*, a tall blue larkspur (*Delphinium scopulorum?*), and the heath-like *Bryanthus breweri*, the latter unfortunately past flower, but said to be one of the most beautiful alpine plants of the Sierra.

The Washington lily is very abundant about Lake Tahoe, where it reaches its finest development. Specimens four or five feet high are common, and in favorable seasons it is said that specimens seven feet high, with twenty or thirty flowers on a stem, are sometimes found. The pretty little tiger lily (*L. parvum*) is not at all rare in moist ground, where the stems sometimes carry a dozen or more of their graceful bells.

No attempt has been made in this hasty sketch to give a full list of the plants of the regions visited ; this is obviously impracticable. Such have been selected for illustration as seemed to emphasize the peculiar characters of the districts, and such as would naturally attract the attention of the casual visitor.

No region of equal area in our country offers such great range of conditions as does California, and, as naturally might

be expected, this is reflected in its remarkably rich and interesting flora, which offers a most attractive field to the student of geographical distribution of plants. The state extends over ten degrees of latitude, with a coast line of over 1000 miles, and its highest mountains rise 15,000 feet above sea level. There are regions like the Mojave desert and Death valley which are absolute deserts, while in the northern coast ranges there are points where the annual rainfall probably exceeds 100 inches, and the forests of giant redwoods rival the jungles of the tropics in the rank luxuriance of their vegetation.

The great barrier of the Sierra Nevada and the even temperature of the ocean waters, due to the Japan current, combine to give the whole state a far more equable climate than is found elsewhere in the United States; and in the lowlands, winter, as we know it in the eastern states, does not exist, but instead the year is divided into two sharply marked seasons, the wet and the dry, of approximately equal length in the central part of the state.

Besides these great climatic differences, which have profoundly influenced the native flora, the peculiar topography of California has also been an important factor in determining the origin of many of the plants. Direct communication with the eastern half of the continent is prevented by the great mountain barrier of the Sierra, and the mountains and deserts of the Rocky mountain area. It is only on the north and south that there is free communication with the neighboring regions, and we find, in consequence, a curious mingling of northern and southern plants, with an almost complete absence of peculiarly eastern American types.

The continuous ranges of mountains extending into British Columbia and Alaska offer an easy road for many northern plants, which are equally at home in the coast ranges and Sierra Nevada, and in Canada and Alaska. With the rapid diminution in the rainfall south, most of these finally disappear, and are quite absent from the southern part of the state. Most of these northern genera, *e.g.*, Trillium, Claytonia, Erythronium, and others, are found both in Asia and northeastern America; but there are several Asiatic types which do not reach Atlantic

North America, but are restricted to the Pacific side of the continent. The genus Fritillaria is represented by a number of showy species, one of which extends as far south as San Diego; another striking instance is the western skunk cabbage, Lysichiton, a monotypic plant common to the north Pacific coasts of Asia and America.

In the valleys of the central part of the state and throughout the southern regions the plants are very different from those of the north, and have very little in common with the flora of the eastern states. Mexico and western South America are the regions which are most nearly allied in their flora to this southern district. Most of the characteristic genera of this region are either entirely absent from the Atlantic states, or else represented by very few species. Much of this area is excessively dry, and such plants as the cacti, agaves, yuccas, and other desert types give a very marked character to most of this region.

The central part of the state, especially the region about the bay of San Francisco, is a meeting-ground for the northern and southern floras. In the valleys the flora is largely composed of the southern elements. Such genera as Lupinus, Eschscholtzia, Nemophila, Orthocarpus, Brodiæa, Calochortus, Calandrinia, and other common and showy flowers of the open valleys and foothills, are represented by species either identical with the southern ones or closely allied to them. The flowers of the higher mountains, however, especially those of the moist forests of the outer coast ranges, are largely of northern origin, and these often follow the sheltered canyons down to the level of the valleys, where they mingle with the valley flora.

Probably no feature of our Pacific flora strikes the eastern botanist so forcibly as the preponderance of coniferous trees. From Sitka to San Diego, it is Conifers which give the peculiar stamp to the forests, whether at the timber line on the highest peaks, or battling with the ocean winds along the coast. It is true that in the valleys and on the lower hills groves of oaks, without accompanying Conifers, are met with; these can hardly be said to form forests, and wherever the moisture is sufficient to support a true forest growth, it is the Conifers which are the

prevailing trees. The deciduous trees which accompany them are small in comparison with their gigantic companions, and merely form an undergrowth for these.

Of the sixty or more species of Conifers found on the Pacific Coast, the larger part occur in California, which possesses more species than the whole United States east of the Rocky Mountains. An unusually large number of these are peculiar to the state and of very restricted range. Among the better known of these peculiarly Californian Conifers may be mentioned the two Sequoias, *i.e.*, the redwood and giant Sequoia; *Punis insignis*, and *Cupressus macrocarpa*. The number of endemic angiosperms is also very large.

It is doubtful whether anywhere there are more magnificent forests than the great redwood forests of the coast range or the forest belt of the western slopes of the Sierra Nevada, where grow the great Sequoias in company with noble sugar pines and giant firs and cedars.

In this land of big things nothing has impressed me like these giant trees, the true kings of our American forests.

THE MAINTENANCE OF THE EQUILIBRIUM AS A FUNCTION OF THE CENTRAL NERVOUS SYSTEM.[1]

PROFESSOR HEINRICH OBERSTEINER.

It is difficult for man to exist, more difficult than would be supposed from a superficial consideration. In his earliest childhood man stands—or, better, lies—here in the world and finds before him a series of tasks for which he is but partially fitted. Fortunately, we bring with us into the world a most finely elaborated organism, by which from the beginning a great part of this work is essentially lightened. For example, our hearts beat regularly, we breathe rhythmically, and so forth. For even at birth the mechanism of the circulation and of breathing is so completely developed that these functions can proceed quite independently and without our further assistance. Were we obliged to give our constant attention to these two absolutely necessary functions, where should we find the time for any intellectual labor?

In other fields, however, it is not so easy for us. The child has to practice long before it can sit upright, and still longer before it can stand and walk. But having once thoroughly learned this feat, having made it completely our own, it is no longer necessary — at least under normal conditions — to give our supervision, our conscious assistance, to the equilibration of the body. This is maintained quite unconsciously, while the mind is engaged with other things. We can, for example, follow a process with strict attention while sitting or standing, without becoming upset or falling from the chair — unless perchance we fall asleep.

It is a most wonderful and advantageous physiological ar-

[1] A lecture delivered before the Verein zur Verbreitung naturwissenschaftlicher Kenntnisse in Wien. Translated from the *Schriften des Vereins*, Bd. xxxvii, by Guy M. Winslow, Ph.D.

rangement that just those vital processes which demand the most time, continuing as they do throughout our whole life, need no assistance from our consciousness, but are performed automatically.

It will now be my purpose to show how the preservation of the equilibrium may be accomplished, how we can stand and move without being conscious of the complicated mechanism brought into action, and yet without constantly falling. We shall also take occasion to mention derangements of this mechanism, for right here we shall find many indications which are important for the comprehension of normal conditions.

We begin with the simplest process of standing erect:

> Sehe jeder, wie er's treibe,
> Und wer steht, dass er nicht falle.

What, then, happens when we remain quietly standing erect? In order to do this a great number of our muscles, indeed nearly all the muscles of the trunk and lower extremities, must coöperate. The impulse for this coöperation is transmitted to the muscles from the brain; but in order to stimulate the muscles properly, the brain needs a number of external impressions, sensations, which incite the impulse, and regulate it. We shall then have to inquire how the muscles must coöperate to produce the erect position. We shall endeavor to penetrate farther into the secret of the complicated apparatus of the brain, which works so nicely, and, finally, we shall turn our attention to those sensations which furnish the necessary material for this part of the activity of the brain.

I have mentioned above how great a number of muscles is required simply for standing. It is not necessary, however, that all the muscles concerned should contract; if all our muscles were in a state of strong contraction, making the body stiff and motionless, we should be as unstable as a broomstick which had been placed upright on the floor. It is, rather, necessary that each of these muscles contract with a certain strength, up to a definite point, so that each little inclination of the body be counteracted by a stronger contraction of the opposing muscles, while others are correspondingly relaxed.

There is needed for this a very finely calculated and graduated intensity of action by each of the components of motion, a process which is designated as coördination of the muscles, in this case as static coördination.

Let us again take the stick of wood, which would not remain standing before, and fasten a number of strings to its upper end. Now let us set it up again and pull slightly in different directions, laterally, and a little downwards. Probably it will at first fall over to one side toward the strongest pull, but if we modify the strength with which it is drawn in the different directions, we shall finally cause it to remain quietly standing in a vertical position. A condition of equilibrium has been reached by the proper coördination of the forces acting, the same as occurs with a standing man through the coördination of muscles.

Intentionally I lay special stress upon this unusually important factor of coördination of the muscles, which takes a significant part in each muscular act, even though the result be unsuitable to the purpose which prompts it. Indeed, we may go still farther and say that wherever several factors coöperate for the attainment of a uniform result, a proper determination of the intensity with which each shall act is absolutely necessary. Without going into complex social conditions I may give an illustration from art.

If, in the well-known Seventh Symphony of Beethoven, the bassoonists conceive a desire to play fortissimo in the wrong place, the effect will be destroyed as much as if the contrabass were to play a very light piano in a place written forte. Each player finds certain signs with his notes, the dynamic signs of expression, which show him not what, but how, he ought to play.

The corresponding signs which make known to our brain how each muscle must act for the attainment of static coördination are imparted to it by different sense organs. As the first, though not the most important of these, I mention the touch sensations of the sole of the foot. If we stand, and still more if we walk, we feel the ground beneath our feet. It needs no long reflection to perceive how difficult simply standing

would be for us if our feet were insensible. We can understand this easily, because we are able at any time to bring the sensations of touch and pressure in the sole of the foot before our consciousness.

Far more important, however, are sensations of whose existence many men know absolutely nothing, namely, those from the joints, tendons, and muscles. By the nerves from these organs the brain receives information in regard to their condition, but this takes place in such a way that these sensations do not generally overstep the threshold of consciousness. They serve almost exclusively automatic purposes, and would therefore unduly and uselessly burden our attention. But it is an established fact that we may be conscious of the muscular sense. We are conscious, for example, of the strength, the exertion which is required to lift a weight; indeed, we can estimate the weight of the object lifted by the strength expended, and distinguish the heavier object from the lighter. For this reason the muscular sense has also been called the strength sense. The pains of fatigue, or the strong muscular pains caused by cramps, are perceived by means of the same nerve tracts.

There are many who deny the existence of a muscular sense; for example, Wundt. He prefers to refer whatever is ascribed to this sense to the sensations of the central nervous system. But many facts, especially pathological conditions, incline us to admit a muscular sense.

Having now become acquainted with the existence of the muscular sense, we can comprehend that in this region we must seek the most important sensations which render possible the coördination of the muscles and standing erect.

The great significance which the joints and joint nerves attain in this process as a result of their position is self-evident. But these stimuli, transmitted from the locomotor apparatus, that is, the muscles, joints, tendons, etc., to the central nervous system, may perhaps be utilized in another way for the coördination of the muscles. E. Hering proposes the following: At each slightly energetic movement, for example the bending of the arm, those muscles which produce the opposite movement—the antagonistic muscles, in this case the extensor muscles of

the arm — are relaxed; thus the nerves of these muscles are stimulated, and there results a certain reflex contraction of these opposing muscles. An excess of the intended movement is thus prevented. If this opposition, this restraint, be for any reason lacking, the movement becomes disordered and unsteady, as we indeed see in certain diseases.

Less striking, but yet not to be overlooked, is the rôle which the so-called visceral sensations play in the process under consideration. From all the viscera there are nerves which convey sensations to the spinal cord and the brain; of these sensations also we are, as a rule, unconscious, except when the organ from which they come is diseased. As soon as we become conscious that we have a liver, then the liver is usually diseased. The viscera are suspended freely within the body cavity; each change in the position of the body must then produce a greater or less displacement of the viscera. This displacement is not generally a matter of consciousness, yet an unconscious sensation is transmitted to the brain. It is evident, then, that the visceral sensations are of essential assistance in the preservation of the equilibrium.

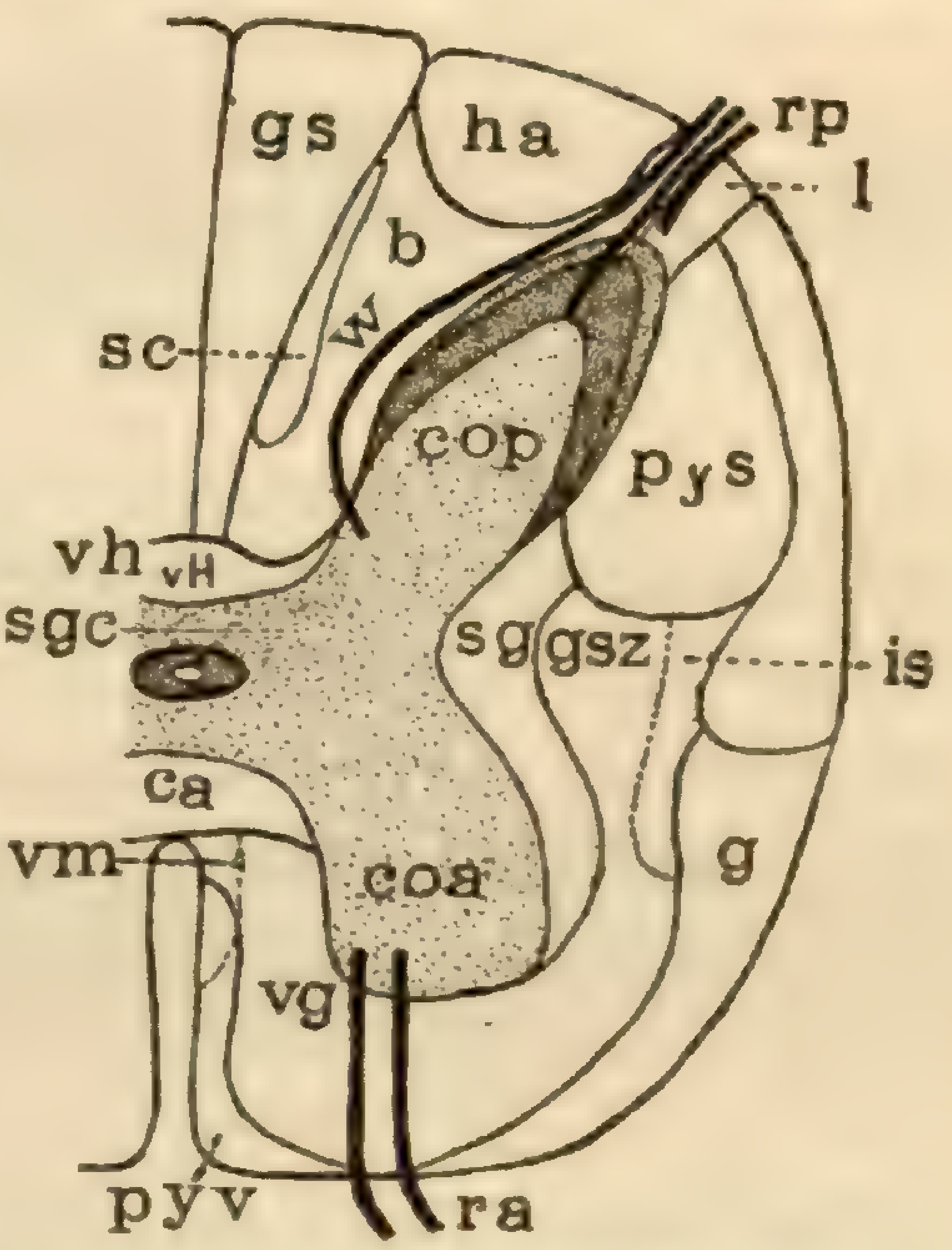

Fig. 1. — Transverse section of spinal cord. *b*, Burduch's column; *ca*, anterior commissure; *coa*, anterior horn of gray matter; *cop*, posterior horn; *g*, Gower's bundle; *gs*, Goll's column; *pys*, lateral pyramid tract; *pyv*, anterior pyramid tract; *ra*, anterior root; *rp*, posterior root of spinal nerve.

It will be in order to introduce here a brief anatomical note. We have thus far spoken of the sense of touch, especially in the soles of the feet, and of sensations from the joints, tendons, muscles, and the viscera. These are all perceived by means of nerves which enter the spinal cord through the posterior roots (Fig. 1, *rp*). If we examine a transverse section of the spinal cord (Fig. 1), we find about its center a reddish-gray mass (*cop* and *coa*), the gray matter, while the remainder of the section is made up of the white matter. This white matter consists

almost exclusively of nerve fibres, which for the most part run longitudinally along the spinal cord. Thus, if we cut the spinal cord transversely, we have a countless number of cross-sections of nerve fibres. But, although even under the microscope the whole field of white matter appears quite homogeneous, we know that it is divided into a number of fibre bundles of varying significance and function. Thus we distinguish in each half section of the spinal cord about sixteen different regions.

The nerves mentioned above, and which are of significance to us, enter the spinal cord through the posterior roots, and take their further course to the brain, perhaps exclusively by way of the posterior bundles (*gs*) and (*b*), the lateral cerebellar tracts (*ks*) and Gower's bundle (*g*).

I would not have bothered you with these dry anatomical data if we were not to need them later.

I turn now to another class of sensations, which likewise are scarcely known to the non-scientific, since they, like the muscular sense, perform their function outside the sphere of consciousness, and become apparent only when they are irritated.

Under this head let us consider the inner ear, that part of the auditory organ which lies deeply buried in the hardest bone of the skull, the temporal bone. We find in this two principal parts; one has the characteristic form of a snail shell, and is hence called the cochlea; the other consists of three curved tubes which are connected in such a way that the two ends of each open into a small sac-like enlargement, the utriculus. These tubes are called the semicircular canals; together with the utriculus they form the labyrinth of the ear. If one imagines a plane passed through each of these three arches, it will be found that the three planes are perpendicular to one another. It is only when the cochlea itself becomes diseased or destroyed that a defect of hearing occurs. This effect is not produced by injuries to the labyrinth. In the latter case, on the other hand, very peculiar disturbances of the equilibrium are experienced. These facts were first demonstrated by Flourens. I cannot here go further into the very interesting investigations which were carried out later, especially by Golz, Breuer, and Ulach, among others, for the determination of the

function of this little organ. Even in the lower forms, for example in the crabs, Kreidl was able to establish the same fact.

The result of this discovery, as well as the observation of diseases of the labyrinth in man, has taught us that this part of the inner ear, that is, the labyrinth, represents a sense organ which gives to the individual information in regard to the position of the head in space. This organ produces the sensation of turning, and thus controls the perception and maintenance of equilibrium. We have, then, acquired a sense of equilibrium, the peripheral sense organ of which is to be found in the labyrinth, and which transmits its sensations to the brain by means of a part of the auditory nerve.

The method of action of this sense organ is as follows: both in the utriculus and at places in the semicircular canals, the ampullæ nerves terminate in cells from which cilia project into the inner lumen; there is also in the utriculus, at the end of these nerves, a cluster of fine crystals — the otoliths. The utriculus and semicircular canals are filled with a fluid, the endolymph, which is agitated by each movement of the head, and which thus bends the cilia. The otoliths contribute to the reënforcement of this stimulation. At the beginning of a turn of the head in the plane of one of the canals, the fluid, as has been shown by Breuer, lags behind, and so strikes in the opposite direction against the cilia.

The task of maintaining the equilibrium is, again, essentially lightened by the sense of sight. This point hardly needs a detailed presentation. The impressions of vision give us information as to any change in the position of our body, and every one knows that we stand or move unsteadily in the dark or with closed eyes. And here I will emphasize the fact that the sensations from the eye muscles are also essential components of the mechanism of equilibration.

Recapitulating, then, we may say that the following sensations coöperate for the equilibration of our bodies: touch sensations, which are perceived by means of nerves from the joints, tendons, and muscles; sensations from the labyrinths; and, finally, optic sensations. All of these sensations are collected

and employed in the brain with such a resulting effect upon our body musculature that the desired object, the preservation of equilibrium, is attained.

We have now to investigate further what part of the brain is intrusted with this important and complicated function.

First, I may again point out that we are, as a rule, entirely unconscious of many of the sensations concerned in this process. And since we are justified in concluding that, in order to become conscious, sensations must pass to the cortex of the cerebrum, we are from the first inclined to look for the organ of equilibration which controls the coördination of the muscles elsewhere than in the cortex of the cerebrum. There is also a series of facts which makes it highly probable that the part of the central apparatus sought is to be found in the cerebellum.

The cerebellum is an organ which is clearly separated from the rest of the central nervous system, and which in its finer structure differs essentially from all other parts of the brain. It has also a special and peculiar function. In comparison with the other parts of the brain it is not proportionately well developed in all animals. In mammals and birds the cerebellum is not only relatively large, but its surface is increased many times by numerous delicate and usually deep parallel furrows. In the Amphibia and many reptiles, on the contrary, it is reduced to a simple small ridge. While the first-mentioned groups require very sensitive and complicated muscular action for the maintenance of the equilibrium while standing, running, and flying, in the other groups a much simpler apparatus suffices for mere crawling or jumping. In the fishes the cerebellum is larger than in the Amphibia, yet with the exception of one of the cartilaginous fishes it is still smooth. Frogs, it is true, swim, but with far less rapidity and precision than fish. Thus we actually find a certain parallelism between the size of the cerebellum and the delicacy of the muscular coördination.

Another anatomical fact is now to be considered. We are acquainted with certain tracts of the spinal cord which we know convey to the brain a part of the sensations necessary for the preservation of the equilibrium. We know that, directly or indirectly, all of these tracts are intimately connected with the

cerebellum, and some of them pass entirely into it. No connections between the nerve fibres arising from the labyrinth and the cerebrum are known, but the labyrinth has many direct and indirect nervous connections with the cerebellum.

It is found, therefore, that, with the exception of the optic nerve, all those sensory tracts which are used in equilibration collect in the cerebellum. And there certainly are connectives between the optic nerve and the cerebellum, yet in regard to this our knowledge is very incomplete. These are the purely anatomical considerations which point to the cerebellum as the center of coördination or equilibration. But physiological experiment also shows us facts which lead to the same conclusion.

Only a carefully performed and rightly interpreted experiment can inform us as to the function of this part of the brain. Erroneous observations and interpretations have ascribed to the cerebellum all possible functions; for example, the seat of the soul, the emotions, the memory, and so forth.

If one wound the cerebellum of an animal badly, or if he extirpate a portion of it, there is no proper regulation of the muscular contractions, and there is a decided disturbance of the equilibrium, resulting from the defective innervation of the muscles. An animal thus treated makes the most senseless and inopportune motions without accomplishing its purpose; yet it hears and sees, and its intelligence appears not to be interfered with.

Similar phenomena occur in men having diseases of the cerebellum. As we shall return to this point again, I will here only briefly note that, in most cases of serious disease of the cerebellum, disturbances of the equilibrium and dizziness are present.

We have found, to summarize the above, not absolutely certain proof, but still a number of important reasons which fully justify us in searching in the cerebellum for the central apparatus for muscular coördination, and the resulting preservation of equilibrium.

Thus we have solved a part of the problem presented to us. We can now represent diagrammatically (Fig. 2) the whole apparatus which must take part in the process of equilibration. To the cerebellum (*k*) there are transmitted various sensations

coming from the skin (*hs*), the muscles and joints (*ms*), the viscera (*vs*), the labyrinth (*l*), and from the eyes (*a*). All these sensations are combined in the cerebellum into a single resultant nervous impulse which influences or modifies the movements incited by the cerebrum in such a way that the coördinated effect desired is attained; so that the different muscles *m* and *m* contract in the proper manner. This may be stated somewhat as follows: The cerebellum does not — on the basis of the sensations conveyed to it — apportion the necessary stimuli to the muscles concerned in an action separately, but distributes it as a whole to the muscles concerned.

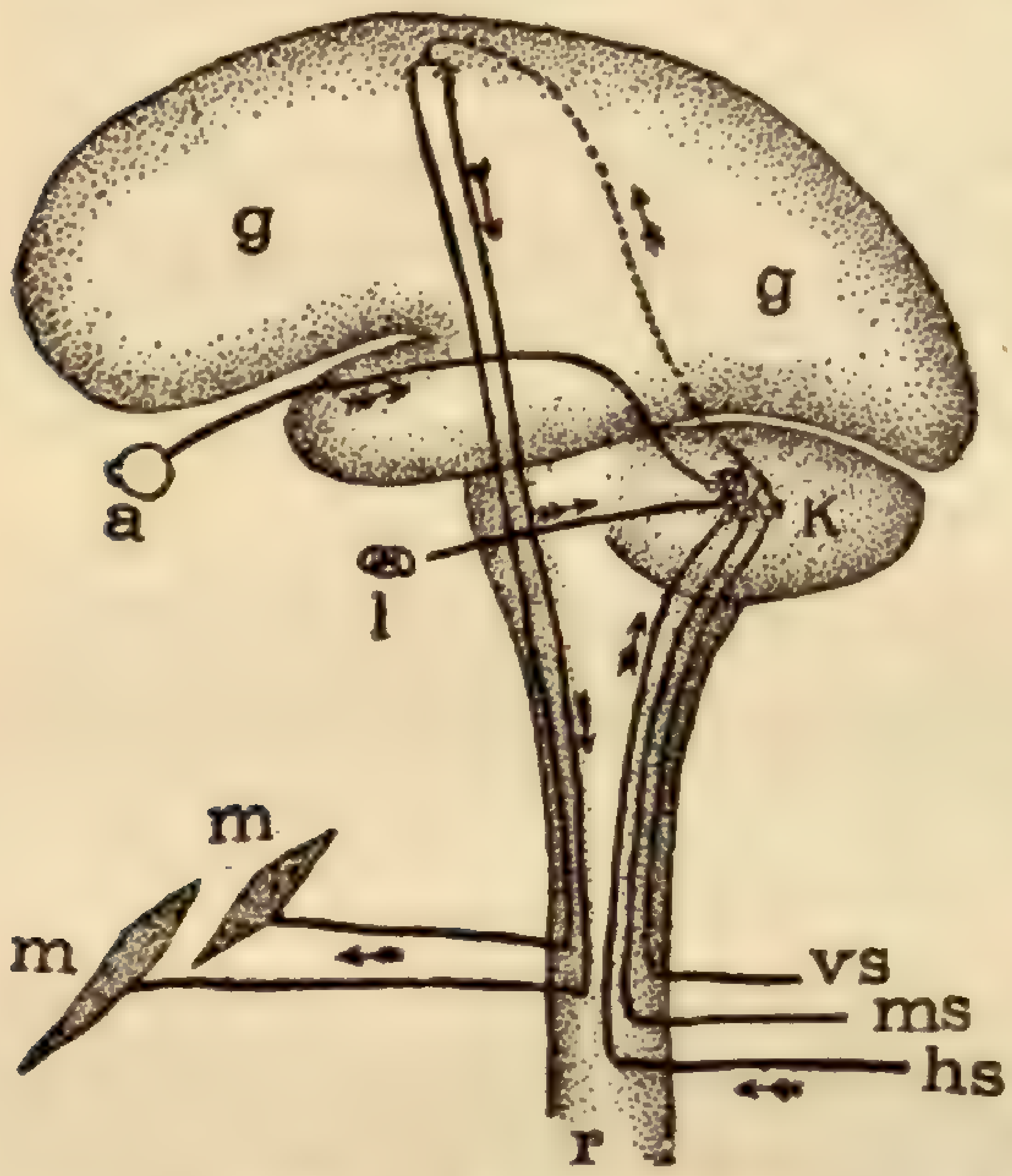

FIG. 2. — Diagram of nerve tracts employed in coördination for maintenance of the equilibrium. The arrows indicate the directions of the nervous impulses. *a*, eye; *g*, cerebrum; *k*, cerebellum; *l*, labyrinth; *hs*, *ms*, *vs*, nerves for impulses from skin, muscles, and viscera; *m*, muscles.

In the above diagram we may consider the relations of certain sensory nerves to the cerebellum, as well as to the tracts which receive their impulses from the cerebellum and transfer them to the muscles, to be definitely made out. But it is still a question where the cerebellum exerts its regulatory influence upon our movements; where we have to suppose the connection, here represented by a dotted line, is really to be found. But there are also many other gaps in our knowledge of our central nervous system; and for the object at present under consideration this question seems not to be of essential significance.

It is now to be investigated how this coördinating apparatus may act under different circumstances. The simplest task is that with which we have started out, namely, the maintenance of static coördination, that is, the preservation of equilibrium while standing erect under perfectly normal conditions.

If any one attempts to stand erect and perfectly motionless, he finds that he is unable to do so. A smoked plate has been

placed horizontally above a person trying this experiment in such a way that a point projecting from the cap touched upon the plate. Each movement of the head is then registered upon the smoked plate, and an irregular zigzag line is obtained as the expression of the oscillations of the body. The sway from side to side amounts to one and one-half centimeters; that from before backwards, to two centimeters. The oscillations increase with fatigue and become sensibly greater if the experimenter closes his eyes, or if any other of the factors concerned in the process of equilibration is eliminated. And the oscillations become yet greater in certain diseases, accompanied by the destruction of coördination. We learn from this experiment that it is not possible for us to stand perfectly quiet, but that we are always balancing ourselves within certain limits. By this process certain muscles are brought much into use, and after a time they become greatly fatigued. Then we change our position a little, so as to bring other muscles into play, and at least in part to relieve those exerted earlier. We also learn from these experiments that it is more difficult to maintain our equilibrium while standing if any of the sensations usually participating in the process are inactive. Closing the eyes results in greater oscillations, and anesthesia of the soles of the feet, as I have already remarked, essentially increases the difficulty of standing. The result of a loss of the muscular sensations, or of the sensations from the labyrinth, would be still more serious, while the greatest disturbance of all occurs when several of the component sensations are simultaneously wanting, especially if, as the result of disease, they deceive us by false sensations.

A healthy man under normal conditions maintains his balance while standing in spite of the above-mentioned oscillations, and he is quite unconscious of this process and the attendant difficulties. But if any essential factor of the apparatus for keeping his balance be eliminated or altered in its action, he feels the difficulty of performing the task properly, a feeling which we designate as dizziness. Dizziness is the sensation of the loss of equilibrium combined with the feeling of difficulty in counteracting this loss. As will be easily understood, fear is often associated with dizziness.

We shall, then, find quite different causes for the occurrence of dizziness, according to the part of the balancing mechanism which has its functions destroyed. But first I must briefly mention a peculiar kind of dizziness which is not preceded by any injury to the nervous system, namely, physical dizziness.

We must constantly remember that the process of equilibration usually takes place unconsciously. But if we find ourselves upon a narrow plank lying across a brook, or on the edge of a precipice, we become conscious not only that we have a certain difficulty to overcome in order not to fall, but also that such a fall would be attended by very serious results to us. We attempt, therefore, by voluntarily exerting all our muscles, by extending the arms, and in other ways, to render the process of keeping our balance easier. But in reality we aggravate the difficulty and perhaps finally fall. Fear makes us especially clumsy. It is as if one were riding a beast of burden along a narrow mountain path. As is well known, in such a case one should give himself over to the animal, which is accustomed to travel safely; but if the rider becomes afraid, and tries to guide the animal with the reins, it may easily happen that both perish together. In this figure the animal represents our unconscious coördination, which we destroy when we try consciously to assist it.

If we return now to our diagram, it will essentially aid us in our study of the different kinds of dizziness.

We will begin with the different varieties of sensation which participate in the maintenance of the equilibrium. In the disease of the spinal cord known as tabes dorsalis the posterior roots are first affected. The sensations from the muscles, tendons, and joints then become reduced or arrested. I notice that occasionally the tactile sensations of the skin do not suffer until late, or perhaps not at all; while, on the other hand, the destruction of the visceral sensations is not rare.

As a consequence of the loss of the muscular sense, a man afflicted with this disease shows peculiar symptoms. His motions are not regular, not properly gauged: in walking his feet go shuffling and bumping along, while if he sits they will cross; again, one foot is lifted much too high in the air, though

at the same time he may not be able to send sufficient stimulus to his muscles to produce the contractions necessary for his purpose. This defect in the control of the muscular innervation is called ataxia, and since it is dependent on a disease of the spinal cord it is known as spinal ataxia.

This disease offers yet another phenomenon. During its first stages the patient is generally able to stand quite firmly, even though his feet be placed near together, thus reducing his stability as much as possible. But no sooner does he close his eyes than he begins to totter and become dizzy, finally falling, unless he is supported. The explanation of this phenomenon, known as Romberg's symptom (static ataxia), is to be found in the fact that in closing the eyes the control of the equilibrium dependent on them, a very important factor, is lost.

There is a particular kind of dizziness, called optical dizziness, which depends upon a derangement of the nerves of the eye muscles. Let us imagine that our eyes move without our being conscious of it. It will seem to us that the objects about us have changed their positions in relation to our body ; and since walls, trees, and pieces of furniture, which we know to be fixed, appear in a different direction, we conclude that our body has moved. This erroneous impression passes to the center of coördination, and is answered by a compensating movement of the body, which is naturally unsuitable ; then we again feel a loss of balance. Thus is explained the uncertainty in standing and walking which is observed as resulting from many kinds of disturbances in the movement of the eye.

That dizziness also arises from the digestive organs, by means of the visceral sensations, is a fact well known to the laity. But the process here taking place is in no way clear to us.

The phenomena of dizziness and loss of balance, which have their origin in the ear labyrinth, the special organ of equilibration, are of particular interest. Here also we must distinguish whether we have to do with false sensations which are transmitted from this sense organ to the brain, or whether this kind of sensations is entirely lacking.

It is plain to see that the latter condition might easily be followed by less serious results than the former ; for if the

sensations from the labyrinth are lost, a more or less complete compensation may be made by the other senses. But the central nervous system will be led into error by false impressions from this organ, and thus be perplexed, even though the control of the other senses remains intact.

I will now call attention to the familiar phenomenon of whirling dizziness, which is produced when we turn swiftly about the long axis of our body. We have seen that the nerves terminating in the labyrinth are stimulated by the flow of the liquid contained in it — the endolymph. But after turning rapidly this fluid does not immediately come to rest, as we see when a vessel containing water is rapidly rotated and then suddenly stopped. By this continued movement of the endolymph the nerve ends are stimulated for a time after the body has entirely ceased to move. False sensations are thus produced which give us a wrong impression of the actual movement of our body and cause dizziness — the whirling dizziness.

The same effect is obtained in whatever direction the turning takes place. From quick movements upward or downward, also, similar results occur. In America, where very tall buildings are now constructed, the use of elevators is frequently attended with dizziness, by which elevator boys are particularly affected.

Seasickness can also be traced, at least in part, to similar conditions. But I will here observe that the viscera also, though in a much less degree, may participate in the production of whirling dizziness and seasickness. If the head be held still, and quick rotating motions be made with the trunk, by which the freely suspended viscera are set in motion, a slight dizziness is often felt.

A peculiar pathological phenomenon, known as Menière's disease, or better as Menière's symptom complex, here deserves special mention. This malady is characterized by dizziness and a buzzing and snapping noise in the ears. One concludes, with much reason, that in such a case the ear labyrinth is directly or indirectly injured. In some cases of this kind, bleedings have been found in the semicircular canals, and fissures in the temporal and other bones.

A complete absence of the sense of equilibrium is found in a

number of deaf-mutes, in about fifty-six per cent of whom the ear labyrinth is entirely degenerated. Such deaf-mutes go tottering and stumbling along with their legs spread far apart; if, while in the water, they become submerged, they lose their orientation in space. But, as can be easily understood, and as has been demonstrated by Kreidl, they are free from whirling dizziness; likewise (according to the investigations of Pollak) they are immune from galvanic dizziness, which is produced in a normal individual when a galvanic current is passed through the head.

We have seen that through the abnormal or arrested activity of a number of sensory nerves, disturbances of equilibrium and dizziness are produced; we must now go farther and investigate the action of the central nervous system in this relation.

We here pass to so wide a field of observation, however, that I must limit myself to indicating only the rudest outlines.

The cerebellum has been recognized as the most important central organ of equilibration. Severe diseases of the cerebellum are therefore characterized by dizziness and loss of equilibrium. The gait of one thus diseased is peculiarly unsteady, best compared to that of a drunken man. In this case also irregular motions result, but still they are quite different from those I have described for tabes. This kind of defective motion is called cerebellar ataxia.

But a glance at our diagram shows that another part of the central nervous system plays a rôle in keeping the balance. We are next to consider that nerve tract by means of which the cerebellum exerts its regulatory influence upon the tract controlling motion.

In the diagram (Fig. 2) I have indicated this tract by a dotted line, in order thus to express the fact that its course is not perfectly known to us. But notwithstanding this somewhat unsatisfactory condition of our knowledge, we must expect that similar phenomena can be produced from different places in the brain.

Dizziness with severe disturbances of the equilibrium may occur, the brain parts concerned being severely diseased. It is sufficient for them to experience a changed or imperfect

nutrition. This occurs, for example, with a general loss of blood, anæmia, or when the loss of blood affects the brain alone; in cases of this kind the symptom increases when the body is quickly raised to an upright position, and decreases when it is placed horizontally.

In a similar manner the nourishment of the brain is interfered with by certain poisonous substances, many of which, such as tobacco and alcohol, especially affect the balancing apparatus. The dizziness and unsteady motions resulting from nicotine poisoning are well known, and yet more familiar are the staggering movements following too free indulgence in alcoholic drinks. From the great similarity which exists between these symptoms and those of cerebellar ataxia, one may perhaps reasonably conclude that the effects of alcohol are more detrimental to the processes of nourishment in the cerebellum than to those in other parts of the brain.

Finally, mention should be made of numerous other circumstances which may interfere with the circulation in the brain, and by which, again, dizziness may be caused. Here belong, for example, epileptic dizziness, the feelings of dizziness which are often observed at the beginning of acute contagious diseases, and many other cases.

According to the plan which we have thus far been following, those derangements of equilibrium which originate in the locomotor apparatus should now be considered. Here the conditions are essentially simpler. If a muscle which is of importance in standing, or a whole group of such muscles, become paralyzed, the patient is no longer able to stand erect. Even a partial paralysis of such muscles will be sufficient to render standing, without external support, impossible. The result is exactly the same in whatever part of the locomotor apparatus the cause of this paralysis lies; be it in the muscles, nerves, in the spinal cord, or in the brain.

My purpose was to show you in the merest outlines how we are enabled through our central nervous system to maintain our equilibrium. But I have also had a subordinate aim; I wished to illustrate to you by an example the method by which

we arrive at conclusions in regard to such questions. You have seen how we have laboriously to collect the material from different sources; not only anatomy and experimental physiology are studied, but we must add to this a knowledge of pathological conditions. And this latter furnishes us with particularly important and instructive facts; therefore I have allowed myself to devote considerable attention to the pathological disturbances of equilibrium.

Finally, I wished to show you by this example how great a part of the functions carried on by our organism is performed entirely apart from consciousness. Our conscious activity is thus released from what would otherwise be a very considerable burden.

If, then, as I stated at the beginning of my analysis, it is difficult for man to exist, yet we should be thankful to Nature that a great part of the labor imposed upon us is made essentially easier by the organization of our central nervous system, and that time is thus given us to engage in higher intellectual pursuits.

Let us thankfully recognize the value of this gift.

EDITORIAL COMMENT.

Annales du Musée du Congo. — The Congo Free State, one of the last born of the nations, is demonstrating its right to a place in civilization by the publication of a series of monographs on its natural history. These are issued by the order of the Secretary of State as *Annales du Musée du Congo.* Four articles, or fascicles, have appeared — two "Illustrations de la Flore du Congo," by Wildemann and Durand, and two "Matériaux pour la Faune du Congo," by G. A. Boulenger. These last, by the able ichthyologist of the British Museum, treat of the fishes of the Congo, numerous new species being described with excellent figures. The Free State is to be congratulated on its early attention to its local natural history, as well as on the wise choice of the hands in which its material is placed.

A Botanical Calendar. — Under the editorship of P. Sydow the first number of the *Deutscher Botaniker-Kalender* has made its appearance — a little book of 198 pages of text and many pages of advertisements of botanical interest. The first 108 pages are devoted to the calendar proper, there being one page for each week, with the dates of the birth and death of distinguished botanists. It is noteworthy that there are only twenty-two days in the year without such data, and on some days there are as many as four entries. The calendar is printed on one side of the page only, leaving the opposite side for notes and memoranda, for which there is also room under each day. The contents of the book includes the usual tables of coinage, weights and measures, and postal regulations; the rules of botanical nomenclature of the Royal Botanical Garden at Berlin; a list of the cryptogamic exsiccata, systematically arranged; a list of botanical gardens, geographically arranged; a similar list of botanical and natural history museums; and, finally, an alphabetical list of the collections in botanical museums and herbaria. The omissions and inaccuracies usual to the first edition of a book of this character are painfully in evidence as regards American botanical matters. The value of the work would be much enhanced if it included the *personnel* of the different botanical institutions given, and also a botanical directory. We cannot, however, but praise this effort of Dr. Sydow,

and are glad to know that there is so much room for improvement. We wish the *Kalender* every success, and hope to see it a permanent institution, and call upon American botanists to see that our botanical institutions are fully and correctly represented in the edition for 1900. The book is published by the Borntraegers at Berlin for three marks.

The Beiträge zur Biologie der Pflanzen, published at irregular intervals under the editorial care of the late Professor Cohn, of Breslau, has been recommenced with Dr. Brefeld as editor. While the retention of the original title is entirely commendable, it is to be regretted that the new volume should be issued as "Herausgegeben von Dr. Ferdinand Cohn." A change in expression, similar to that made on the title-page of the *Jahrbücher für wissenschaftlichen Botanik* after Professor Pringsheim's death, would better have expressed the facts, while securing the desirable perpetuation of Professor Cohn's name in connection with the journal.

"Natural Science," with the initial number of Vol. XIV, the first under the new management, makes its appearance in a new dress. The greenish tint of the cover has given way to a grayer tone, and the typography of the title-page is somewhat changed. The journal is now printed on heavier calendered paper, and is, on the whole, improved in appearance. The general makeup is unchanged, except for the addition of the new column of "Fresh Facts," which comprises brief references to facts of interest in current literature. We wish our esteemed contemporary a most prosperous and happy new year.

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

African Skulls.[1]— F. Shrubsall has had exceptional opportunities to study African crania, and has produced a model paper describing the skulls of the Bantus of South Africa. The large number of crania in the series, some two hundred, has enabled him to fairly revel in seriations and averages. How great a satisfaction it is to the craniologist to gain access to a large series is known only to those who have dealt with small numbers of specimens, "too few to furnish satisfactory conclusions," or "too fragmentary for definite results." On the other hand, the study of such a collection involves an immense amount of labor, some idea of which may be gained from the number of measurements recorded in the accompanying tables, which, by the way, appear to better advantage in the enlarged *Journal of the Anthropological Institute* than in the former demi-octavo size. The metrical method is followed in the paper, and the text suffices merely to interpret the figures. This we believe to be the most satisfactory method, though it must be admitted that the descriptions of the "impressionist school" of craniologists have a certain value.

Mr. Shrubsall concludes that the most striking feature of the A-bantu crania is that they are remarkably uniform from all parts of the area under consideration. In the south the skulls show marks of intermixture with the Bushman-Hottentot race. In the east the cranium is also modified, and the question of mixture with Semito-Hamitic peoples is raised. In the northwest the presence of negroid characters indicates crossing with the negroes from the region north of the Congo. Finally, "the obvious affinities" of the Bantus "are with the Monbuttu of Niam-Niam, and the peoples of the Zeriba country, and the Welle-Nile divide." These conclusions are in accordance with the teachings of history and philology. F. R.

Ceremonial Stones. — In the *Proceedings of the Linnæan Society of New South Wales* for December, 1898, Mr. Walter R. Harper

[1] Shrubsall, F. A Study of A-bantu Skulls and Crania, *Jour. Anthrop. Ins.*, N. S., vol. i, Nos. 1, 2, pp. 55–103.

gives "a description of certain objects of unknown significance, formerly used by some New South Wales tribes." These objects are cigar-shaped, of stone or clay, attaining a maximum length of fifty-five centimeters. A number of theories have been advanced to account for their use, but they have not yet been satisfactorily identified. They are decorated with a number of "broad-arrows" and parallel gashes. The seven plates which accompany the article show that these markings are of a rude character, and that considerable variation exists in form and decoration. Mr. Harper brings forward no decisive evidence to account for their use, but concludes with the statement that they are either "pounders" or "ceremonial stones." The latter is a convenient scrap-basket in archæology, and as Mr. Harper does not prove them to be pounders, it might be well to classify them as ceremonial stones; at all events, they are well described and figured in this paper, and others may be able to answer the question raised. F. R.

ZOÖLOGY.

Adriatic Sponges.[1] — Dr. von Lendenfeld continues in this monograph his exhaustive description of the Adriatic sponges begun in 1891.[2] Like the earlier works of the series, this is divided into three parts. The first part contains a complete list of the literature on the group; the second, a description of the Adriatic species; the third, a comprehensive review of the structure and classification of the Clavulina in general.

The classification adopted by von Lendenfeld in this series of memoirs is as follows:

- Porifera
  - Class Calcarea
  - Class Silicea
    - Subclass Triaxonia
      - Order Hexactinellida
      - Order Hexaceratina

[1] Von Lendenfeld, R. Die Clavulina der Adria, *Abhandl. Kais. Leopold. Carol. Deut. Akad. Naturf.*, Bd. lxix (1898), 12 Taf., p. 251, Halle.

[2] Die Spongien der Adria, Die Kalkschwämme, *Zeit. f. wiss. Zool.*, Bd. liii (1891); Die Hexaceratina, *Ibid.*, Bd. liv (1894); Die Tetractinelliden der Adria, *Denkschr. Kais. Akad. Wiss. Wien* (math.-naturw. Classe), Bd. lxi (1894).

- Subclass Tetraxonia
  - Order Tetraxonida
    - Suborder Tetractinellida
    - Suborder Lithistida
  - Order Monaxonida
    - Suborder Clavulina
    - Suborder Cornacuspongiæ.

Von Lendenfeld defines the Clavulina as marine Monaxonida, possessing as a rule a skeleton made up of rhabdus-like, mostly monactinal, megascleres, arranged for the most part radially to the surface in bundles, and not forming a network in the interior. Occasionally without a supporting skeleton. Mostly without, or with very little spongin. Occasionally with well-developed spongin skeleton. Microsscleres, when present, always asters or microrhabdi, never chelæ, sigmas, or toxas. If a well-developed spongin skeleton is present, microscleres of aster or rhabdus type are always found.

This suborder is divided into three tribes: (1) Euastrosa, with euasters, or, if none, then without skeleton. Other microscleres may occur with euasters. Occasionally with spongin. (2) Spirastrosa, without euasters, but with spirasters or other microscleres. Occasionally with spongin. (3) Anastrosa, without microscleres.

In the suborder are included 26 genera, distributed in 10 families. Ridley and Dendy (*Chal. Rep.* on Monaxonida) divide the group into 2 families with 10 genera. Vosmaer (Bronn's *Klass. and Ord.*) makes 2 families with 10 genera, and an Anhang, consisting of 9 genera (chiefly Gray's) of boring sponges, which he provisionally accepts and unites under the family name of Clionidæ. Von Lendenfeld's group owes its size partly to its more comprehensive character, partly to the separation of certain genera from the Clavuline families as recognized by Vosmaer, Ridley and Dendy, such genera being reincorporated as distinct families.

The following brief review of the ten families included in the Clavulina will make plain the scope of the group as defined by von Lendenfeld. In the Tethyadæ are included, along with the type genus and Tethyorrhaphis Lend., a boring sponge (Xenospongia-aspis), and Sollas's two genera, Asteropus and Coppatias (united by von Lendenfeld as Asteropus), reckoned by Sollas as among the Tetractinellida. 'he two genera, Chondrilla and Chondrosia, included by Vosmaer al- with Oscarella in his Oligosilicina, are here separated from th r genus and placed in distinct families, Chondrillidæ and dæ (Oscarella by von Lendenfeld is assigned to the Tetractinellida). The family Stelligeridæ is made to include two

genera withdrawn from the Axinellidæ, a family regarded (Ridley and Dendy, *Chal. Rep.*, p. lxii) as transitional between the Halichondrina and Clavulina. These two are Stelligera Gray (Raspailia Vosmaer, 1887) and Hemiastrella Carter (Epallax Sollas, 1887). The above four families constitute the Euastrosa.

The family Placospongidæ includes Placospongia Gray, placed by Sollas among the Tetractinellida. The family Dendropsidæ includes Ridley and Dendy's genus Dendropsis withdrawn from the Axinellidæ. Instead of uniting them in a single family (Spirastrellidæ), after the manner of Ridley and Dendy, von Lendenfeld separates the two genera Spirastrella and Latrunculia, creating the family Latrunculidæ for the latter. Under the family name of Spirastrellidæ he groups with Spirastrella two genera (Vioa Nardo and Thoasa Hancock) of boring sponges; two genera, Ficulina Gray and Halicnemia Bwk., included by Vosmaer and by Ridley and Dendy, under generic names Stylocordyla and Polymastia, in the Suberitidæ; and Alectona Carter, including forms widely separated by Sollas under generic names Scolopes (fam. Scolopidæ close to Suberitidæ, Sollas) and Amphius (included by Sollas as a Tetractinellid in fam. Epipolasidæ). The above four families constitute the Spirastrosa.

Under the Suberitidæ von Lendenfeld groups five genera (Papillella, Polymastia, Tentorium, Trichostemma, Suberites), included by Vosmaer either in the Polymastidæ or Suberitidæ, and by Ridley and Dendy in the Suberitidæ; and two others, Sollasella Lendf. and Suberanthus n.g. The family Stylocordylidæ is erected by von Lendenfeld for a new genus Astromimus, together with Stylocordyla Thomson, which he withdraws from the Suberitidæ, where it is placed by Vosmaer and by Ridley and Dendy. The Suberitidæ and Stylocordylidæ make up the Anastrosa.

Von Lendenfeld gives a statement of the phylogenetic views which underlie the classification he proposes. Suberites, Spirastrella, Tethya have been the productive genera. They with Asteropus have been independently derived from Tethyorrhaphis. From Tethya have been derived, directly or indirectly, Xenospongia, the Chondrillidæ, Chondrosidæ, and Stelligeridæ. From Spirastrella have been derived the Placospongidæ, Latrunculidæ, Dendropsidæ, also directly or indirectly the other genera of the Spirastrellidæ, and the Anastrose genus Papillella (Suberitidæ). From Suberites have been derived directly, or indirectly, the other genera of Suberitidæ (except Papillella), and the Stylocordylidæ.

The Anastrosa (more particularly Suberitidæ) are thus conceived

of as having had a polyphyletic origin, in part (Papillella) from the Spirastrosa, though chiefly from the Euastrosa (Suberites derived from Tethyorrhaphis). Since von Lendenfeld regards (p. 210) Tethyorrhaphis as the "Grundform aller Clavulina," he evidently does not take very seriously the idea (p. 206) that the Euastrosa and Spirastrosa have been independently evolved from different Tetractinellid families — though in the paragraph referred to he apparently countenances this belief.

Of von Lendenfeld's ten families, all but the Latrunculidæ and Dendropsidæ are represented in the Adriatic. Of his twenty-six genera, fifteen, represented by thirty species, are here found. Seven new species (*Asteropus incrustans*, *Stelligera nux*, *Placospongia graeffei*, *Vioa topsentii*, *Vioa ramosa*, *Suberites gracilis*, *Astromimus luteus*) are described, and of the twenty-three already described species, seven for the first time have been found in the Adriatic.

In the descriptive part of the work will be found details of interest concerning the histology and skeleton, together with observations in many cases on the appearance and behavior of the living sponge.

H. V. Wilson.

Revised Classification of the Unionidæ. — Students of the Unionidæ will welcome the revision in the arrangement of the species of this group, which Mr. C. T. Simpson has introduced in Mr. C. F. Baker's report [1] on the Mollusca of the "Chicago area." Anatomical features — other than those of the shell simply — are made the basis for the revision, the structure of the marsupia, for example, being employed as a diagnostic character. The genus *Margaritana* is rejected, *Unio* and *Anodonta* are broken up, the old genera *Alasmodonta*, *Strophitus*, *Quadrula*, *Obliquaria*, *Plagiola*, and *Lampsilis* are revived, and a new genus, *Anodontoides*, is erected, to provide for the new and more natural grouping of the species. The shell of each of the fifty forms is described at length, and in most instances the external anatomy of the animal is also given. The local distribution is tabulated, and the geographical and geological range of each species is reported. Excavations about the city have revealed as fossils many of the species now reported as living in this area. Measurements are given, and data upon variation, habitat, and breeding are quite extensive. It is to be regretted that the introductory discussion of the group is not phrased in the terms of modern morphology, that

[1] Baker, F. C. The Mollusca of the Chicago Area, Pt. I, The Pelecypoda, *Bull. No. III, Nat. Hist. Surv. Chicago Acad. Sci.* (1898). 130 pp., 27 plates.

the anatomical descriptions are in some cases omitted or incomplete, that the keys were not in all cases revised to meet the new classification, and that the limits of Mr. Simpson's contributions were not more definitely marked. We also note that *Atax*, the common Hydrachnid parasite of the clam, is incorrectly reported as *Diplodontus*. The plates — half-tones from photographs of the shells — afford abundant illustrations, and are in some cases excellent, though they at times fail to reveal important details of structure, such as the beaks and the hinge teeth. The full descriptions, the abundant illustrations, and the keys make the work a valuable handbook for American collectors and students of fresh-water Pelecypoda. C. A. K.

Rotifera and Protozoa of the Illinois River. — The local and seasonal distribution of ninety-three Protozoa and one hundred and eight Rotifera is given by Mr. Hempel [1] as a result of his examination of towings made during 1894 and 1895 in the Illinois River and its adjacent waters. The results reported afford further data indicative of the cosmopolitan distribution of these groups, and the similarity of the pelagic fauna of the fresh water of Europe and America. Some species occur throughout the whole year, or a greater part of it, while others recur only at stated seasons; some reach a maximum in the spring, others in the summer, and still others in the fall, while some reach this condition only in the winter, breeding abundantly under the ice. The predominance of the Brachionidæ among the Rotifera is noticeable. One new species, *Difflugia fragosa*, is described.

C. A. K.

Diurnal Migration of the Plankton.[2] — A single series of observations on the quantity of plankton at certain levels in Lake Leman, by Dr. H. Blanc, suggests a considerable vertical movement, especially of the Entomostraca, toward the surface during the night. Catches were made at the surface, and at depths of 20, 40, and 60 meters in water 100 meters deep. The volume of the catch from surface water at 4 A.M. was 25 times as great as it was at 4 P.M. A large increase also occurred in the catch at the 20-meter level, while at 40 and 60 meters there was no considerable change. The afternoon catch at

[1] Hempel, A. A List of the Protozoa and Rotifera found in the Illinois River and Adjacent Lakes at Havana, Ill., *Bull. Ill. State Lab. Nat. Hist.*, vol. v (1898), pp. 301–388.

[2] Blanc, H. Le Plankton nocturne du lac Leman, *Bull. Soc. Vand. Sci. Nat.*, vol. xxxiv (1898), pp. 225–230, Pl. II.

the surface contained few Entomostraca, but these increased at this level during the night, the Copepoda appearing before the Cladocera, the maximum being attained at 4 A.M. The night catches at the surface and at 20 meters contained great numbers of Ceratium in division. Migration, reproduction, and growth are all factors in this increase in the nocturnal plankton in the superficial layers. No report is made upon the total vertical content of the water, and the data do not afford any clue to the extent of the migration suggested. The position of the thermocline is not indicated.

C. A. K.

Plankton of the Oder.[1] — This potamoplankton is characterized by Schröder as variable, being at a minimum during the winter when the stream is frozen, and in March when it is at flood and full of silt. It attains a maximum during a period of low water in the latter part of the summer. The plankton of the main current is less abundant than that of contiguous bays or of adjacent ponds supplied by the river. It is suggested that the plankton content of flowing water is inversely proportional to the fall of the stream. At all times the phytoplankton of the Oder is relatively small, and is largely composed of diatoms. In the shallower and warmer water of the ponds the Bacillariaceæ are replaced by the Chlorophyceæ and Phytomastigophora. Thus, in general, the diatoms thrive best in cooler water, as in mountain lakes and cold streams, while shade and access of running water favor their development in ponds. In the plankton of the Atlantic Ocean, also, the diatoms predominate in the arctic waters, and are replaced by the Peridinidæ and Schizophyceæ in warmer regions.

C. A. K.

Notes on Nematode Parasites. — 1. It is not often that one is called upon to record valuable contributions to zoölogical literature from the pen of a botanist, but the recently published work of Stone and Smith[2] on nematodes is deserving of more than passing notice. The root-galls produced by certain species of this group are the cause of considerable damage among cultivated plants, and the authors, who were drawn to investigate the subject by reason of its economic importance and bearing on their own department, have given it

[1] Schröder, B. Planktologische Mitteilungen, *Biol. Centralb.*, Bd. xviii (1898), pp. 525–535.

[2] Stone, Geo. E., and Smith, Ralph E. Nematode Worms, *Division of Botany, Bull. No. 55, Hatch Experiment Station Mass. Agr. College* (November, 1898). 67 pp., 12 plates.

a very complete study. From the large amount of valuable matter a few points of especial interest may be selected.

After discussing the economic importance of the question, the structure of nematode worms and the symptoms of their attack, there follows a careful description of the root-gall, in which it is shown that the worms affect the plants, not directly by extracting nutriment, but indirectly by modifying the structure of the root so that the flow of sap is interfered with, and secondarily by weakening it so that it is more susceptible to other diseases. The structure and development of *Heterodera*, the gall nematode, are fully described; and in connection with a careful review of the literature the authors maintain the identity of the German species with that found by Cobb in Australia, that studied by Neal and Atkinson in the southern United States, and that on which they worked themselves in Massachusetts. Although carefully reached, the conclusion is still open to question. The nematodes display great uniformity in general structure, and species are at best often very difficult to distinguish. It is not clear that the lips, together with the oral and caudal papillæ, were examined in all these forms; but these are the characters at present accepted as the most reliable for specific determination. And while specimens of the German form were compared with the Massachusetts variety, it was only the female, while on the analogy of other species in this group the male alone would suffice for specific determination. Furthermore, in some points at least, the habits of the two forms are not in agreement, so that the specific identity can hardly be regarded as established.

The authors have discussed very completely the various methods of treatment for nematode root-galls, and have experimented in detail with most of them. They reach the conclusion that "the most effectual, complete, and practical method of exterminating nematodes in greenhouses is by heating the soil by means of steam," which is both comparatively inexpensive and noticeably beneficial to the soil. While experimenting they noticed the comparative indifference of *Heterodera* to an atmosphere strong in CO_2. This is interesting as confirming for one free living representative of the group what Bunge long ago demonstrated for certain parasitic species. The paper is well illustrated and of permanent value.

2. A good résumé of present knowledge on the nematodes has recently appeared in the form of a somewhat popular article,[1] which

[1] Cobb, N. A. Extract from Manuscript Report on the Parasites of Stock, *Miscell. Publ. Dept. of Agr. Sidney, N.S.W.*, No. 215; also from *Agr. Gazette N.S.W.* (March and April, 1898), 62 pp., 129 text-figures.

contains also noteworthy contributions from the work of the author. The reader is struck at the outset by the breezy character of the author's style, especially noticeable in the first part of the paper on the methods of manipulation, which contains an energetic appeal to study of the group by a wider circle and full directions for carrying on the work. In the second part the anatomy and physiology of these worms are discussed topically under the various systems. Among the more important points which are new may be mentioned a tabulation of the various forms assumed by the pharynx and œsophagus, together with a terminology for the same. Microchemical demonstration of different uric compounds in preparations of the lateral fields strengthens the belief that the ducts in them are associated with the excretory function.[1] The author argues for a respiratory function of the problematical "lateral organs" present in varying form and development in all (?) the free-living forms, but wanting in the parasitic species, and gives some personal observations on the structure of these little known organs in new members of the group. Various hints make it evident that the author has some radical improvements to suggest on the classification of the nematodes. It is to be hoped that they may be published soon, as the present confusion in the group is exceedingly unfortunate for all students.

The article is illustrated by numerous exceedingly well made woodcuts which represent in many cases new species unaccompanied by any further description than the formula after the fashion set by the author for nematodes, yet the advantage of accurate figures is at once evident. Though the cuts are small and somewhat difficult to decipher, they are very exact, and it is agreeable to see illustrations which are new and which represent the real conditions rather than the author's diagrammatic conception of structure; were these figures only a little larger and more distinct they would be ideal.

H. B. W.

Origin and Development of Sense Organs. — Three popular scientific lectures on the origin and development of sense organs and sensory activities in the animal kingdom have been given by Dr. P. Steffan before the Senckenbergian Natural History Society.[2] In his intro-

1 The recent researches of Nassonow, *et alii*, have appeared since the publication of the article.

2 Steffan, P. Entstehung und Entwickelung der Sinnesorgane und Sinnesthätigkeiten im Tierreiche, *Ber. Senckenb. Naturf. Gesell.*, Frankfort a/M. (1898), pp. 29–69.

duction the author points out the dependence of our higher mental activities on the materials furnished by our sense organs. Light, heat, sound, materials of taste and of smell, and direct external contact are the stimuli for the eye, ear, tongue, nose, and outer skin. These, the author declares, are all the forms of sensory stimuli and sense organs known. How such a statement is consistent with the author's opinion as to the source of all our mental materials is difficult to understand, unless he be a man to whom pain, fatigue, hunger, and thirst are unknown.

The relation of sense organs to the medium in which the animal lives is next taken up. Organs of taste and touch are equally possible to water- and air-inhabiting animals, but organs of smell, hearing, and sight are of necessity more restricted to the air-inhabiting forms. Smell, the author believes, is absolutely impossible to water animals, though he offers no explanation of the condition in fishes where the organs which become olfactory in the air-inhabiting vertebrates are so well developed.

The remainder of the lectures is devoted to a condensed account of the sense organs of the animal kingdoms. The so-called vegetative senses — touch, smell, and taste — are first considered, and then what are dignified by the title of animal senses — hearing and sight — are dealt with. Practically nothing novel is introduced in this part of the work, the first portion reading like an abstract of Jourdan's *Senses and Sense Organs of the Lower Animals*, and the second being in large part avowedly taken from Carriere's little book on the eye. The popular treatment of a scientific subject is one of the most difficult tasks an author can set for himself, and to prescribe rules for such forms of composition is well-nigh impossible. Superficiality, however, is never to be tolerated, and superficiality is the characteristic of Dr. Steffan's contribution. G. H. P.

Eckstein's Zoologie.[1] — The German medical student has to pass examinations in zoölogy and comparative anatomy, and as a result a number of these compendia exist, apparently intended to enable the student to cram for examination. We are familiar with several of these syllabi, and this of Eckstein seems, on the whole, the best. It contains a large amount of information, clearly arranged under the heads of history, histology, comparative anatomy, physiology, embryology, paleontology, geographical distribution, phylogeny, taxonomy,

[1] Eckstein, Professor Dr. Karl. *Repetitorium der Zoologie, Ein Leitfaden für Studierende.* Zweite Auflage. Leipzig, W. Engelmann, 1898. 8vo, viii + 435 pp.

and the relations of animals to human interests. The book is well illustrated with two hundred and eighty-one cuts, none of which indicate the source from which they were copied.

Crustacea of Norway. — We wish to call attention to the valuable work by G. O. Sars[1] on the Crustacea of Norway, of which the second volume, treating of Isopoda, is now current. Every species is figured, often an entire plate being devoted to the figures of the entire animal and enlarged views of appendages. The text contains a brief description of every species, with valuable remarks on occurrence and distribution, and with synonymy. The last parts have treated of the Oniscidæ (wood lice, etc.), which have a special interest as being the sole large group of terrestrial Crustacea. From the fact that North American Crustacea closely resemble the Norwegian ones this work is of great value to American naturalists who are not regardless of the need of carefully identifying the species they study.

Japanese Pulmonates. — Dr. Jacobi[2] has made a thorough anatomical research on twenty-eight species of Japanese shell-bearing Pulmonata belonging to the genera Helecarion, Conulus, Ganesella, Helix, Eulota, Acusta, Euhadra, Plectotropis, Ægesta, Eulotella, Tristropeita, Slercophædusa, Bulimus, Succinea, and Limnæa. This is conscientious work of a much needed kind, unfortunately limited to alcoholic material; a compact mass of information, free from generalizations. The plates are excellent.

F. N. Balch.

Brooding in Frogs. — The singular brooding habits of a small frog, *Arthroleptis Seychellensis*, from the Seychelle Islands, are described by Professor August Brauer in the current number of Spengel's *Zoologische Jahrbucher*. The eggs are laid in damp places on the ground, and are kept covered and moist by the male until the larvæ are hatched, which occurs at the stage when they are provided with a long tail, and the first traces of the posterior appendage make their appearance. After hatching, the tadpole-like larvæ crawl upon the back of the male and attach themselves by the abdomen by means of secretions elaborated both by the larvæ and the adult.

[1] Sars, G. O. *An Account of the Crustacea of Norway*, vol. ii, Isopoda. Bergen, published by the Bergen Museum, 1897 and 1898.

[2] Jacobi, A. Japanische beschalte Pulmonaten, *Jour. Coll. Sci. Imp. Univ. Tokio*, XII, Pt. I. 102 pp., 6 plates.

Boulenger, in his account of the Venezuelan *Phyllobates trinitatis*, believed that the larvæ attached themselves to back of the parent with the object of being transported from one pool to another. Brauer shows, however, that in Arthroleptis the attached condition is not a temporary one, but that a large part of the development takes place in the back of the male.

Marine Mollusca in the Suez Canal. — M. Bavay (*Bull. Soc. Zool.*, France, XXIII, 9 and 10) gives a list of twenty-five species of marine Mollusca that have been taken in the Suez Canal, six of which are Mediterranean forms, and nineteen belong to the fauna of the Red Sea; of the latter, *Meleagrina radiata* has also been taken on the coast of Tunis. The disparity between the number of Mediterranean and Red Sea forms is explained by the fact that from July to January the level of the Mediterranean is at an average of .4 of a meter higher than the Red Sea, thus causing a current in the canal from north to south, while from January to July the level of the Red Sea stands .3 of a meter higher than the Mediterranean, producing a current from south to north. Now since it is in the earlier months of the year, or during the time of the northward current, that most of the larvæ are hatched, the Red Sea forms are most favored in their migrations.

Hertwig's Summaries in Systematic Zoölogy. — Professor A. A. Wright, of Oberlin College, has put into tabular form the classification adopted by Richard Hertwig in his *Lehrbuch der Zoologie*, and has printed with this a translation of the summaries of morphological and physiological facts given at the end of each chapter. His purpose is to make these summaries accessible to students as an accompaniment to lectures on systematic zoölogy. Professor Wright's pamphlet of thirty-five pages thus forms a useful supplement to Field's translation of the introductory part of the *Lehrbuch*, which covered the subject of general zoölogy. The first edition of Professor Wright's work, published in February, 1897, having been exhausted, a second edition without essential modification has recently been issued.

Fishes of Ecuador. — In the *Bolletino* of the museum at Turin Dr. E. A. Boulenger has a valuable paper on the fishes of Ecuador, collected by Dr. Enrico Festa. Forty-three species are described, many of them new. Among the latter are two marine catfishes, *Arius* (*Tachysurus*) *festæ* and *A.* (*Galeichthys*) *labiatus.*

A New Type of Shark. — Professor D. S. Jordan, in the *Proc. Cal. Acad. Sci.*, Ser. 3, *Zoöl.*, Vol. I, No. 6, describes the type of a

distinct family of Lamnoid sharks from Japan under the name of *Mitsukurina rustoni.* The genus is apparently unique among living forms, its nearest living relative being the genus Odontaspis of Agassiz, a group which contains few recent sharks, but which is rich in fossil forms.

American Gordiacea. — Dr. T. H. Montgomery concludes his second paper on Gordiacea of certain American collections (*Proc. Cal. Acad. Sci.*, Ser. 3, *Zoöl.*, Vol. I, No. 9) with a synoptical key for determining the species of Gordiacea of the North American continent north of Mexico.

Development of the Eel. — An excellent summary of our knowledge regarding the development of the eel is given by Dr. A. König in *Mittheil. d. Sect. f. Naturk. des Oesterreich. Touristen Club*, X, Nos. 8 and 9.

BOTANY.

A New School Botany. — The modern reaction against the old-fashioned way of making elementary botanical instruction consist chiefly in "analyzing" flowers is well exemplified in the present text-book.[1] With the recommendation that "analysis" be postponed, "even though the pupil may pursue it independently at a later time," the author introduces the student at once to a physiological and microscopical study of the protoplasm and vegetative organs of a few Algal, Fungal, Bryophytic, Pteridophytic, and Spermatophytic types. These same types, together with others, are then studied in the second part as regards their morphology, reproductive processes, and life history. This part ends with a cursory view of some of the more important families of flowering plants. A final part devoted to ecology calls attention to a few examples of interesting adaptations of various organs to the work of nutrition, protection, pollination, dissemination, and germination, and directs the student to profitable lines of study in geographical distribution with special reference to plant formations. In an appendix suggestions are given for the collection and preservation of material, note taking, etc.

The illustrations are mostly good, some being of unusual excellence. Certain of the photographic views, however, seem too hazy and con-

[1] Atkinson, Ph.B., George Francis, Professor of Botany in Cornell University. *Elementary Botany.* New York, Henry Holt & Co., 1898. xxiii + 444 pp., 509 illustrations. Cloth 12mo. $1.25.

fused to be of much significance to a beginner. A few of the drawings, as, for example, Figs. 44, 119, 189, 191, 192, 231, 232, 452, and 453, fall decidedly below the general standard of the book. Fig. 431 lacks the lettering necessary to make it significant.

Given a teacher well trained in physiological and microscopical work and a good school laboratory well equipped with modern though not expensive apparatus, this book will be found helpful and stimulating to both teacher and pupil. The student, however, if a beginner in botany, will frequently require the aid of such a teacher to make clear the meaning of passages which assume a knowledge of botanical matters dealt with only in a later chapter or not included in the book at all. Moreover, technical terms are often used before they have been explained, and sometimes different forms of the same word are used without explanation in a confusing way, as, for example, "chloroplast" and "chloroplastid" (p. 67), also "pollination" and "pollenation." It seems unfortunate and entirely unnecessary that the phrase *carbon conversion* should be substituted for the well-established term *photosyntax*.

It needs hardly to be said of a book from Professor Atkinson's pen that it abounds in information which is at once accurate and up to date. The only slips on matters of fact which the reviewer has noticed are the references to Trillium as having compound leaves (p. 313), to the "coral-root" orchid as having roots (p. 320), to the common bed-straw as having several leaves in a whorl (thus ignoring the stipular character of four of the leaf-like organs), and an incorrect floral formula on p. 254.

There are many evidences of hasty preparation and careless proofreading. Slips in English are not infrequent. Thus "shall" and "will" are continually misused, and one meets with such loose expressions as "alike in substance" for homogeneous (p. 5). One is rather surprised, too, at finding the peristome of a moss described as "frazzled."

In spite of its defects, the book is one of unusual interest and will doubtless hold an important place among advanced school books on botany.

F. L. SARGENT.

Microscopic Technique.[1] — As the author states, the writing of "Practica" is to be considered a somewhat thankless task, — it might be well, indeed, were it more generally so considered, — and a

[1] Meyer, A. *Erstes mikroskopisches Practicum.* Jena, Fischer, 1898. 100 pp., 29 figs.

good excuse is assuredly necessary to justify the publication of one. But this little volume, which, as is stated, is to be the first of a series, is not a mere copy or abridgment of preëxisting works of this sort. While from its extreme brevity of form it must, like many other elementary laboratory guides, present only a few rather isolated botanical facts, these facts are better correlated than in many similar books. It is, indeed, somewhat of a relief to find that no attempt is made to review the whole field of botany from A to Z. Possibly the author reserves this task for the more advanced "Practica," which are to follow. The table in which is set forth the most important characters of the tissue elements of angiosperms must prove convenient, at least in memorizing, if in nothing more.

H. M. R.

Schumann's Monograph of the Cactaceæ.[1] — In 1897 Professor Schumann, of the Botanical Museum at Berlin, issued the first Lieferung of a work which was intended to be completed in ten parts, and to contain descriptions, with synonymic references, for all of the sufficiently known species of cacti, as well as a chapter on the means of cultivating these interesting and sometimes beautiful plants. On the fifteenth of December, 1898, the publication of this work was completed by the printing of the thirteenth part, it having proved impossible to condense the entire matter into the limits originally proposed.

Probably there is no more complete nor representative collection of living cacti than that which Professor Engler, the Director of the Berlin Garden, has brought together within the last ten years, and there certainly is no botanist who has of late given so much continuous and careful study to the cacti as has Dr. Schumann. The work which he has just finished publishing is therefore one destined to take foremost rank in the hands of all students of the group, whether botanists or gardeners. The descriptions and keys are concise and, in the main, good. The synonymy adopted, which, as might be supposed, has been conformed to the Berlin rules, is conservative, and therefore reasonably satisfactory. The limitation of species has been effected on very conservative grounds, and while there is little doubt that some of them, as here accepted, will soon be redivided by Dr. Schumann or others, it is far better to have erred in this direction than by the multiplication of names for forms which

[1] Schumann, K. *Gesammtbeschreibung der Kakteen* (Monographia Cactacearum). Mit einer kurzen Anweisung zur Pflege der Kakteen, von Karl Hirscht. Neudamm, 1899. 8vo, xi + 832 pp., 117 ff.

ordinary people cannot separate. The illustrations are well chosen and, for the most part, excellent. Many of them are photo-engraved from drawings copied from classical figures, the source of which, unfortunately, is somewhat obscured by the statement that they are original. T.

Sargent's Silva.[1] — When it was begun, this superb work was intended to be completed in twelve volumes. The twelfth volume, however, recently issued, contains an announcement that a thirteenth volume will be devoted to supplementary material and an index to the entire work. Like its predecessors, the present volume is conservatively prepared and exquisitely published. It deals with the genera Larix, Picea, Tsuga, Pseudotsuga, and Abies. T.

Systematic Plant Anatomy. — Dr. Solereder, whose studies on the anatomy of flowering plants as applied to their classification are known to all botanists, has undertaken the preparation of a synopsis of what is known in this respect of the Dicotyledons.[2] The work is to be completed in four parts, and, though somewhat expensive (36 marks), will be a necessary and welcome addition to every working laboratory. T.

Botanical Notes. — The relation of plants to their surroundings is discussed in an entertaining way by Costantin, in a recent volume of the *Bibliothèque Scientifique Internationale.*

The anatomical means of distinguishing the commonly cultivated barberries are given by Koehne in *Gartenflora* for January.

Systematic plant introduction, its purposes and methods, is discussed by D. G. Fairchild in *Forestry Bulletin No. 21* of the Department of Agriculture.

A series of illustrated articles on the morphology of Anemone, by Janczewski, is brought to a conclusion in the *Revue Générale de Botanique* for December 15.

Orchid hybridizing, now a matter of some commercial importance, as well as of scientific interest, is described by C. C. Hurst in *Nature* for December 22.

[1] Sargent, Charles Sprague. *The Silva of North America.* Illustrated with figures and analyses drawn from nature by Charles Edward Faxon. Boston and New York, Houghton, Mifflin & Co. Vol. xii. vii + 144 pp., 26 plates.

[2] Solereder, H. *Systematische Anatomie der Dicotyledonen.* Ein Handbuch für Laboratorien der wissenschaftlichen und angewandten Botanik. Stuttgart, Enke. Lieferung 1, 2. 1898.

The *Bulletin of the Torrey Botanical Club* for January contains No. 5 of Professor Nelson's papers on New Plants from Wyoming, and a description and figure of *Lacinaria cymosa*, by H. Ness.

Thirty poisonous plants of the United States are described and, in large part, figured, by Chesnut in *Farmer's Bulletin No. 86* of the Department of Agriculture.

Of interest to botanists is a portrait of Sir W. T. Thiselton Dyer, K.C.M.G., the able director of the Royal Gardens, Kew, published in the *Gardener's Chronicle* of January 7.

In the *Berichte der deutschen botanischen Gesellschaft* of December 28, Ule speaks of the adaptation of some Brazilian Utricularias to their mode of life, which is peculiar, since they live in the leaf rosettes of certain Bromeliaceæ.

Under the title Plantæ Mattogrossenses, Dr. J. Barbosa Rodrigues, director of the botanical garden of Rio de Janeiro, publishes descriptions and figures of a considerable number of new or little known species.

The Bermuda Juniper and its allies are disentangled by Dr. Masters in the *Journal of Botany* for January. While the Jamaican tree is referred to *J. Virginiana*, our common red cedar, the tree of Bermuda, *J. bermudiana*, is held to be specifically distinct.

The Iowa Sedges are catalogued, with synonymic notes, by Professor Cratty, in the December number of the *Bulletin of the Laboratory of Natural History of the Iowa University.* The list includes 114 species and varieties, pertaining to 10 genera. Ten species are figured.

Cerastium arvense, var. *oblongifolium*, a form of a common enough weed, is christened The Starry Grasswort and recommended for decorative cultivation by Professor Arthur in *Bulletin No. 74* of the Purdue University Experiment Station.

The *Journal of the Royal Horticultural Society* for January contains the following articles of botanical interest: Economic uses of bamboos, and list of bamboos in cultivation; Water-lilies and hybrid water-lilies, the latter by the well-known raiser of such hybrids, M. Latour-Marliac.

The Botanical Gazette begins its twenty-seventh volume with an interesting address on the vegetation of tropical America, by Professor Warming, whose studies of Brazilian plants are well known.

The same number contains an elaborate paper on the life history of *Lemna minor*, by Otis W. Caldwell.

Möllers Deutsche Gärtner-Zeitung of January 14 contains an article on Mexican orchids in their native home, by Othon Krieger, which is illustrated by reproductions of two photographs presenting a very vivid picture of the abundance of these epiphytes of our plant-houses and of the difficulties attending their collection.

Botanists who may make the acquaintance of the white ash of Australia will not find a species of Fraxinus, but a Eucalyptus, which has been described and figured by Deane and Maiden in No. 91 of the *Proceedings of the Linnæan Society of New South Wales* under the name *E. fraxinoides*. The same number contains descriptions and figures of two additional species of Eucalyptus, by R. T. Baker.

GEOLOGY.

The Isthmus of Panama, as has been shown by a geological reconnoissance made by R. T. Hill,[1] is an ancient mountain range much reduced in height and deeply dissected by erosion. The drainage system is well developed and consists of several principal streams, which have many rapidly flowing branches near their sources, but comparatively long, low-grade trunks into which the tides extend many miles from the sea. The larger streams generally are characterized by drowned mouths and actively corrading head waters.

There is an absence on each border of the isthmus of a coastal plain, similar to that on the Gulf and Atlantic borders of the United States. The uplands come boldly down to the sea in a series of bluffs and headlands, separated by the partially drowned valleys. On each shore, however, there is a submerged platform, which extends out to about the 100-fathom line, where the bottom descends rapidly into water of great depth. The topography of these submerged shelves indicates that they were formerly coastal plains across which the present streams were extended and excavated channels. A downward movement of the land has submerged the former coastal plain and given origin to coastal swamps, and permitted the encroachment of the sea far up the ancient, low-grade valleys.

[1] Hill, R. T. The Geological History of the Isthmus of Panama and Portions of Costa Rica. Based on a reconnoissance made for Alexander Agassiz. *Bulletin of the Museum of Comparative Zoölogy at Harvard College*, vol. xxviii (1898), No. 5, pp. 151–285, with 19 plates.

The lowest pass across the isthmus, which is a drainage col between the head waters of two opposite flowing streams, is but 287 to 295 feet above the ocean. If the isthmus should subside about 300 feet, a connection would be made between the waters of the Atlantic and the Pacific. None of the passes through the mountains, however, give evidences of ever having been straits connecting the bordering oceans. One of the most important conclusions reached by Hill from several lines of investigation, is that there has been no oceanic connection across the isthmus since Tertiary time. There is, indeed, considerable evidence that this land barrier has existed since Jura-Trias time, with perhaps a shallow passageway across at the close of the Eocene; but even this ephemeral connection has not been definitely proven. In a footnote the opinion is expressed that the Tehuantepec isthmus, composed of cretaceous rocks, has "remained land since its earliest origin."

The conclusion in this connection seems to be that the Central American and Mexican region has been above water at least since the close of the Tertiary. This is of special importance to the students of the Glacial epoch, inasmuch as a subsidence of a portion at least of the Central American region, and a consequent cessation of the Gulf Stream, has been postulated, on purely hypothetical grounds, to explain climatic changes in the northern portions of America and Europe. The antiquity of Central America is also of much interest to biologists, since it is in harmony with the well-known differences in most of the marine species in the waters it separates.

Much information is recorded by Hill in reference to the rocks of the isthmus, the geological structure, the decay of the surface material under a warm climate with excessive rainfall, etc. The appendices contain the following reports on the collections brought home: invertebrate fossils, by W. H. Dall; foraminiferal deposits, by R. M. Bagg; and igneous rocks, by J. E. Wolff.

The report is illustrated by three instructive sketch-maps in contours, which unfortunately are without titles or scales, four sheets of profiles and sections, and twelve reproductions of photographs, several of which illustrate scenes along the Panama Canal.

ISRAEL C. RUSSELL.

PETROGRAPHY.

Experimental Petrography. — Morozewicz[1] has just published a long paper on "Experimental investigations upon the formation of minerals in magmas" that will unquestionably take a place among the most important contributions to experimental geology that have been made within recent years. The author fused known mixtures of the various rock-producing compounds in a glass-furnace and thoroughly studied the resulting products. The conclusions reached by him are full of suggestiveness. The way seems to have been opened for a long line of important investigations to follow, some of which have already been entered upon.

The details of the experiments cannot be entered upon here, but some of the conclusions arrived at may be briefly indicated.

1. The structures of cooled magmas appear to depend upon exterior conditions of crystallization and upon their chemical composition, quantitative as well as qualitative.

2. The order of crystallization is determined by no one condition, such as fusibility, acidity, etc., but it depends upon a number of variable conditions, one of the most important of which is the quantity of the various constituents present as compared with their solubility in the molten mass. The ability of a substance to supersaturate the magma depends primarily upon its nature, the nature of the other substances composing the magma, and its temperature.

3. So far as the experiments touch upon the question of the differentiation of magmas, they seem to indicate that a molten mass may separate into layers or parts differing in density, and that this difference may be due to the fact that the bases FeO, MgO, CaO, separate as silicates by crystallization earlier than the remaining constituents.

Two pounds of granite, with the composition given below (I), were heated for five days. The mixture yielded a mass of glass which in its upper portion contained unmelted quartz grains and a considerable quantity of tridymite. Though the glass between the quartz grains in the upper portion of the crucible presented the same appearance as that in the lower parts, the composition of pieces taken from the two parts was found to be quite different. Under (II) we

[1] *Min. u. Petrog. Mitth.*, vol. xviii, pp. 1 and 105.

have the analysis of the glass from the upper part, and under (III) that of the glass from the lower portion.

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O		Total.	Sp. Gr.
(I)	68.9	19.7	1.4	1.2	1.0	2.7	4.7	=	99.6	2.716
(II)	73.65	14.08	2.33	1.94	.65	2.61	3.86	=	99.12	2.2384
(III)	59.20	22.30	3.83	3.71	1.23	3.26	5.40	=	98.93	2.484

The Basic Rocks of Ivrea. — The basis rocks in the neighborhood of Ivrea, on the south side of the Alps, are shown by Schaefer[1] to be the result of cooling of a single magma. This yielded norites, diorites, gabbros, peridotites and both basic and acid dyke-rocks. The norites include hornblendic varieties, and the diorites, bronzitic, hornblendic, and biotitic phases. All these rocks have been subjected to the action of mountain-making forces. The norites have become schistose without suffering any essential mineralogical change. Some of the diorites have simply been made schistose, others have undergone a further change in that their dark, compact hornblende has passed over into a light green amphibole, while a final stage of alteration is represented by green schists, composed of zoisite, plagioclase, actinolite, chlorite, and epidote.

The dyke rocks cut the large basic masses and are always closely related to them chemically. The principal types are a labradorite (Labradorfels) and a fine-grained black rock which the author calls valbellite. This is made up of bronzite, olivine, and brown hornblende with pyrrhotite, spinel, and magnetite as accessories.

The Basalts of Steiermark. — Sigmund's[2] studies on the basalts of Steiermark are continued in an article in which are described the magma-basalts and basalt-tuffs of Fürstenfeld and the feldspar basalt of Weitendorf. The composition of the magma-basalt is shown by the figures below.

SiO_2	TiO_2	Fe_2O_3	FeO	Al_2O_3	CaO	MgO	Na_2O	K_2O	CO_2	H_2O		Total.
46.76	tr.	5.33	5.62	17.93	8.24	7.31	3.53	2.20	1.33	1.83	=	100.08

Petrographical Notes. — Reinisch[3] has found a specimen of teschenite in the museum at Minussinsk. It is labeled as having come from east of the salt lake Staniza on the river Bjelyi-Jjuss, Minussinsk parish, Jenisseisk gouvernement, East Siberia. It resembles very closely the West Carpathian rock. Among the other specimens from

[1] *Min. u. Petrog. Mitth.*, vol. xvii, p. 495.

[2] *Ibid.*, p. 256.

[3] *Ibid.*, vol. xviii, p. 92.

the same region, melaphyres, melaphyre-tuffs, granites, amphibolites, and contact metamorphosed limestones have also been identified.

Becke[1] records an analysis of the leucite-basanite lava of 1891–93 from Vesuvius as follows:

SiO_2	Al_2O_3	FeO	Fe_2O_3	CaO	MgO	Na_2O	K_2O	P_2O_5		Total.
48.99	19.82	5.26	2.59	8.13	2.82	3.17	9.06	.33	=	100.17

The tonalite gneiss of Wistra, Carpathia, has the composition:

SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	Loss.		Total.
63.09	18.89	3.48	2.02	1.97	6.18	3.14	1.30	.63	=	100.70

Coleman[2] gives a few brief descriptions of some of the rocks met with in the course of his studies of the gold regions of Western Ontario. Among them are diorites, diorite gneisses, a porphyrite, a pyroxenite, and a hornblende porphyrite from Grand Presque Isle, Lake of the Woods. The hornblende porphyrite consists of phenocrysts of hornblende, containing in their interiors remnants of augite and a ground mass composed of quartz, plagioclase, augite, and some orthoclase. Near Peninsula and Port Caldwell, on the north shore of Lake Superior, are coarse diabases, gabbros, augite-diorite, and porphyrites, and associated with them are red rocks, called by the author augite-syenites, diorites, and syenites. Some of the augite-syenites are aggregates of orthoclase and augite, while others are made up largely of pegmatite. Near Lake Wahnapital, in the Sudbury district, diabases, granite, arkoses, graywackes, and dolomites occur.

[1] *Min. u. Petrog. Mitth.*, vol. xviii, p. 94.

[2] *Rep. Bureau of Mines* (Ontario), 1898, p. 145.

NEWS.

In our January issue we announced the death of Dr. Vincenzo Diamare of the Institute of Comparative Anatomy of the University of Naples. We are unable now to trace the source of our information, but Dr. Diamare writes us that he is alive and well, and desires to live on. We wish Dr. Diamare a long and useful life and beg that he will forget our unfortunate error.

A botanical club has been organized in Washington with Professor Edward L. Greene as president and Charles L. Pollard as secretary.

The list of officers and councillors elected for the present year by the Philadelphia Academy of Natural Sciences is remarkable for the few names known to science.

The borings in the coral reef at Funafuti have been discontinued at a depth of 1114 feet. The drill was then in what is called "coral reef" rock, but as yet no studies have been made to ascertain whether it be of recent or extinct forms.

A movement is being inaugurated to increase the endowment of the University of Cambridge. $2,500,000 is desired, and two persons have already pledged $100,000.

The British Association meets in Dover this year.

There was an earthquake in Mexico, January 24, lasting three minutes. Three hundred houses were damaged and ten were completely destroyed.

At the R. I. College of Agriculture and Mechanic Arts (Kingston), the special course of instruction in poultry culture for 1899 began on January 9, to continue four weeks. Nearly forty applications for enrollment for the course were received, but owing to limited accommodations the class has been kept down to about twenty in number. Several who could not take this course have enrolled their names for the next in 1900.

Bulletin of the Cooper Ornithological Club is the title of a new bi-monthly bird journal, published in Santa Clara, Cal., under the editorship of Chester Barlow. The sphere of the journal will be

limited to the ornithological interest of the extreme west, more especially California, and will serve as the organ of the Cooper Ornithological Club.

Many naturalists will probably be interested to learn that the house of E. Merck, of Darmstadt, have begun the publication of a new magazine, *Merck's Digest*, which will give accounts of the various chemicals manufactured by the firm, with reports upon their physiological action. As we understand, the magazine will be supplied free to all chemists and physiologists applying for it.

A successor to E. Ray Lankester as Linacre professor of Comparative Anatomy in the University of Oxford will be elected this spring.

The Royal Microscopical Society has elected Mr. E. M. Nelson to the presidency.

The Russian Geographical Society has established a seismological observatory in Irkutsk, Siberia.

A natural history museum was opened at King Williams Town, Cape Colony, October 5.

Applications for the use of the American women's table at the Naples Zoological Station should be sent to Dr. Ida H. Hyde, 1 Berkeley Street, Cambridge, Mass. Dr. Hyde will give information as to cost of living, etc., to any who may wish it. Two students can occupy the table at the same time — a fact which in some cases would make the study in Naples more agreeable.

The Biological Laboratory of the Brooklyn Institute of Arts and Sciences, located at Cold Spring Harbor, Long Island, will be open for its tenth season during July and August, 1899. The regular class work occupies six weeks from July 5. Courses are offered in High School Zoology by Dr. C. B. Davenport, of Harvard University, who is also the Director of the Laboratory. In Comparative Anatomy, by Professor H. S. Pratt, of Haverford College; in Invertebrate Embryology, by Professor C. P. Sigerfoos, of the University of Minnesota; in Botany, especially of Cryptogams, by Dr. D. S. Johnson, of Johns Hopkins University, assisted by Professor F. O. Grover, of Oberlin College; in Bacteriology, by Mr. N. F. Davis, of Bucknell University; in Microscopic Methods, by Mrs. Gertrude Crotty Davenport, formerly instructor at Kansas University. Opportunities are afforded for Original Investigations, especially in the Variation of

Animals with reference to the Origin of Species, the latter work being under the direction of Dr. Davenport. The laboratory offers dormitory and boarding accommodations on the grounds and under the control of the director. The laboratory is equipped with a naphtha launch, bacteriological apparatus, and a good working library. The tuition fee is $20; board costs $4.50, and rooms $1.50 or $3.00 per week. Application for admission or for the announcements may be made to Professor Franklin W. Hooper, 502 Fulton Street, Brooklyn, N. Y., or to Dr. Charles B. Davenport, Harvard University, Cambridge, Mass.

Appointments: Mr. W. Anderson, of the Indian geological survey, director of the newly instituted geological survey of Natal; M. Güntz, professor of mineralogical chemistry in the Faculty of Sciences at Nancy; L. B. Wilson, demonstrator in pathology and bacteriology in the University of Minnesota.

Deaths: Dr. Giuseppe Bosso, bacteriologist in the University of Turin, January 17; Wilhelm Dames, professor of geology and paleontology in the University of Berlin, December 22, aged 55; Fr. Gay, of the University of Montpellier, France, a student of the algæ, aged 40; Major Jed. Hotchkiss, of Staunton, Va., a well-known writer on subjects in the field of economic geology, January 18, aged 71; Pastor Christian Kaurin, of Sand Jarlsberg, Norway, student of mosses, May 25, 1898, aged 66; Henry Alleyne Nicholson, professor of natural history in the University of Aberdeen, and well known for his textbooks and his paleontological researches, January 19, aged 54; T. Caruel, professor of botany in Florence, Italy.

CORRESPONDENCE.

THE TRUE FUNCTION OF THE UNIVERSITY OF THE UNITED STATES.

The following contribution to the discussion opened by Dr. Dall in the February *American Naturalist*, on the subject of a university of the United States, has been received from the recording secretary of the George Washington Memorial Association. — Ed.

To the Editor of the *American Naturalist:*

Sir, — With the growth of the graduate departments of existing universities of the United States, a growth which would astonish any one who had not been in the closest relation with one or many of these universities, the need which existed a few years ago for a national graduate university, with instruction leading to the Doctorate, is gradually diminishing. There is, however, left for the proposed University of the United States a unique field, one which the universities of the states cannot hope to fill — that is, the encouragement and support of research.

The fact may as well be faced that the general education of an undergraduate college course, with at the best a thesis on some special point, does not fit one to take up a subject for research and treat it broadly. The rapid progress in all branches of science makes it necessary that for a genuine advance into new fields of knowledge long and careful training in methods is necessary. The thesis for a Doctorate is in the majority of cases an expression of this careful training under the eye of a master, the subject of the thesis having been suggested by the master, and its progress watched and directed week by week ; hence with the taking of the Doctor's degree, but not before, the student is well prepared to take up an independent piece of work.

In the bill before the Senate Committee on the University of the United States is a section which should not be lost sight of or slurred over. It is : "The University shall have authority to establish with other institutions of education and learning in the United States such coöperative relations as shall be deemed advantageous to the public interest."

In a wide interpretation of this section is, it seems to me, the solution of the vexed question of the University of the United States.

The Morrill Bill of 1862, which gave the foundation of many of the state colleges — with its supplement of 1890 — and the Hatch Bill of 1887, which founded the Agricultural Experiment Stations, together form the basis for higher education and research in the states at the expense of the national government. An extension of this kind of support to the higher departments of learning in the states would disseminate the interest and give opportunity for training in research. By this means all of the degree-conferring machinery of a national university could be relegated to the universities of the states.

The selection which Dr. Dall, in the *American Naturalist* for February, mentions as necessary before students shall be admitted to opportunity in the government departments at Washington would thus be accomplished. A thesis for Doctorate would be the test for ability to use the opportunity.

By generous coöperation certain resources of the departments could be used by a special student without expecting instruction in the ordinary sense from the chief of divisions, and thus not be a burden.

The recent address of President Harper before the University Club of New York outlines a plan for a federation of universities which may make the basis for a national university. Some such plan as this, modified by the combined wisdom of a committee of experts, can surely solve the problem of the university side of the question, *i.e.*, what branches of learning can to best advantage be furthered in any one university.

The unification of the Scientific Bureaus of Washington, the exact degree in which they can give opportunity for research without impairment of their usefulness, — these questions should be discussed and carefully considered by experts also; but the serious difficulty of opening these Bureaus to students comes from the possible great number of applicants who would be attracted by a free opportunity. There are 4000 graduate students in the universities of the United States. The number is rapidly increasing, and there may before long be 10,000 students who might apply for admission to opportunity in Washington, thus embarrassing and clogging all work. Therefore a larger outlook must be taken by those who advocate a national university. A plan must be devised whereby the government may do its share toward the support of graduate instruction in universities and also more generously support the real research done under government auspices.

The government lands are, perhaps, too nearly exhausted to make

possible a repetition of the Morrill land grant to the states; but it would be possible to issue 5% bonds which benefactors of higher education could buy for the support of graduate work in a special institution. By making these bonds inalienable a permanent fund would be established. The low ruling rate of interest would thus make the matter a genuine piece of coöperation on the part of the government, and in so far as the 5% exceeds that rate there would be a government grant.

It is, then, to emphasize the fact that the most recent thought concerning the formation of a national university does not contemplate flooding the District of Columbia with a body of untrained or partly trained students that this letter is written. It is desired that the government foster research, establishing a national university with branches, providing in the central establishment broader opportunity for research, increasing in the state branches the facilities for training graduate students.

Susanna Phelps Gage.

Ithaca, N. Y., February 9.

GASKELL'S THEORY OF THE ORIGIN OF VERTEBRATES FROM CRUSTACEAN ANCESTORS.

To the Editor of the *American Naturalist:*

Sir, — Since the Annelid theory of the origin of vertebrates, at one time so generally and enthusiastically advocated, has failed to realize the expectations of its adherents, interest in the subject has steadily fallen off, and the various attempts to substitute something in its place have gained only individual or, at most, a very small number of followers.

The impression has steadily gained ground that in spite of its very great importance the problem of the origin of vertebrates is no longer a fruitful one for discussion, because the evidence accessible is so general in character that one may make out a reasonable theory based on almost any invertebrate that one may be pleased to select. We believe, however, that there is no reasonable justification for this state of mind, and that perhaps it may be in a measure overcome by showing how any radical departure from certain lines of procedure, even if the utmost liberty is exercised in the destroying of old organs and the creation of new ones, fails to make the solu-

tion of this problem any easier, and in the end leads to hopeless confusion. It will, therefore, be interesting and profitable to consider some of the difficulties into which Mr. Gaskell is led in his attempts to solve this problem by the novel method of comparing the dorsal surface of an arthropod with the dorsal surface of a vertebrate.

It may be stated incidentally that Mr. Gaskell adopts, without acknowledgment, the same lines of argument in reference to many homologies between vertebrates and arthropods that were used in my first paper on this subject in the *Quarterly Journal*. This is notably the case in regard to the paleontological evidence, the relation of the endosternite of arachnids to the cartilaginous cranium of vertebrates, and to the causes for the disappearance of the old mouth in the concentration of the thoracic neuromeres around the arachnid œsophagus, although these facts are quite inapplicable to his theory.

Briefly stated, Gaskell maintains (*Journ. of Physiol.*, 1889, p. 191) that the nervous system of vertebrates is composed of two essentially different parts: first, a preëxisting, non-nervous tube, consisting of the epithelium of the canalis centralis and cerebral vesicles, and the various supporting elements derived from it; and, second, the true nervous elements, consisting of a "bilateral chain of ganglia connected together by means of longitudinal and transverse commissures." The infolding of the medullary plate of vertebrates shows us, he maintains, the simultaneous development of two different organs, the one the nervous system, and the other the tube of supporting tissue, p. 193. This tube of supporting tissue, "which is not nervous and never was nervous," and which is coextensive with the canalis centralis and the cerebral ventricles, Gaskell regards as the remnants of the alimentary canal of a crustacean-like ancestor. The ventral cord and the supraœsophageal ganglia of the crustacean ancestor have in vertebrates fused with and grown around the old alimentary canal to form the true nervous elements of the spinal cord and brain. *No reversal of surfaces is called for by this transformation*, for the ventral surface of an arthropod is regarded as homologous with the ventral side of a vertebrate. . . . He maintains that the one reason why they (the champions of the origin of vertebrates from the appendiculata) have not been able to make any real advance in their views, has been the difficulty of accounting for the altered relations of alimentary canal and nervous system in the two groups. His theory "solves this difficulty,"

not by turning the animal over, but by transporting bodily the crustacean nerve cords and alimentary canal from the ventral to the dorsal side. By this simple process everything of importance that happens to lie between the dorsal and ventral surfaces must be either swept out of existence or forced into some corner where it undergoes extensive and complete degeneration. The result is a metamorphosis so profound that morphologists have completely failed to recognize the organs of the crab in their new forms and places. According to Gaskell, during the transition from crustacea to vertebrates, the crab's heart is nearly crowded out through the back by

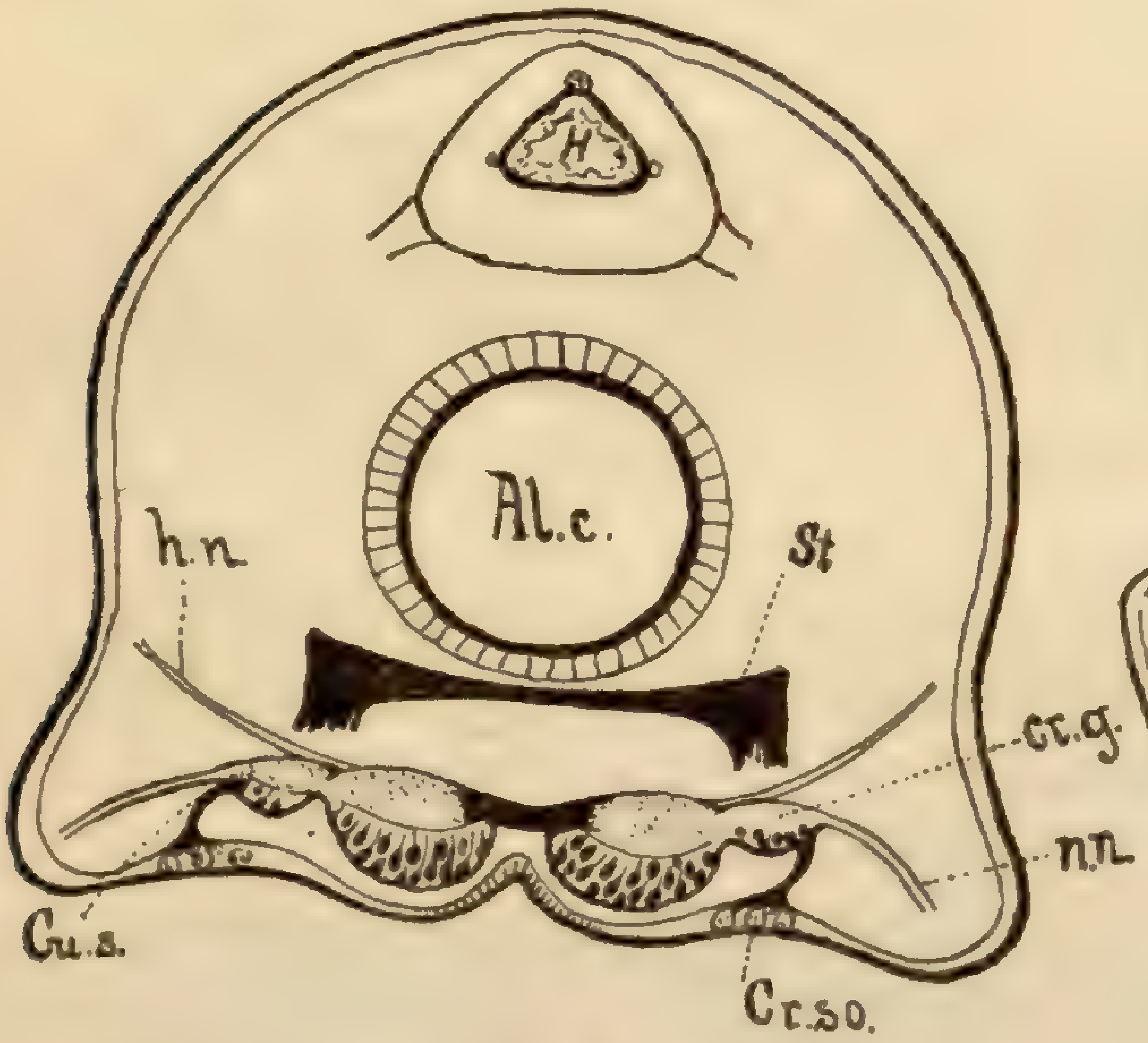

Fig. 1.

Fig. 2.

Fig. 1. — Diagrammatic cross-section of an arachnid (Limulus) in the head region, showing the relative position of heart, alimentary canal, endosternite, and principal peripheral nerves and commissures.

Fig. 2. — Cross-section of a vertebrate illustrating Mr. Gaskell's theory that the arthropod nerve cords, alimentary canal, and endosternite have been transferred to the original dorsal surface where the heart and alimentary canal undergo extensive degeneration.

the dorsal movement of the nerve cords, although it still lingers in Ammocœtes, where he has detected it as "that peculiar elongated organ, composed of fattily degenerated tissue, which lies between the spinal cord and the dorsal median skin." It is not clear whether it was the peculiar elongation of the organ or the presence of fat in it that enabled him to recognize the heart of Limulus in such an unusual place. Gaskell also proves, in the same manner, that the nephridia, or coxal glands of arthropods, have been disguised as the pituitary body of vertebrates; the genital part of the opercular appendages, as the thyroid glands and pseudo-branchial groove; and he shows how the gigantic liver of crustacea is reduced to a mass

of "sub-arachnoidal glandular tissues," that helps fill up the cranial cavity, and thus keeps the brain in place. The straight intestine is discovered under the guise of the central canal of the spinal cord and the "cephalic stomach" as the ventricular cavities of the brain. These are only a few of the renovations to which the crabs must submit in their efforts to become vertebrates. There is not much left that can be used to advantage in the "new crab," except the skin and bones, and Gaskell makes a good deal of them, although he does not display as much ingenuity in doing so as in some of the instances quoted above, because the essential points of resemblance between the cartilages and the dermal structures of Limulus and those of vertebrates have already been pointed out by the author. Gaskell hopes to explain some time how our eviscerated ancestors acquired a new heart, kidneys, and productive organs, as well as a new alimentary canal complete, from mouth to anus.

Gaskell argues that he is justified in "violating the embryological unities," as he calls them, on the grounds that there is much scepticism abroad concerning the validity of the germ layer theory. But this weakness of the germ layer theory can hardly be construed as a license to transfer a crab's entire alimentary canal and nervous system from the ventral to the dorsal surface without obtaining some authority from established facts, yet the assumption that this transfer has taken place forms the foundation of Gaskell's theory. The conception is untenable, not because the supposed transfer of organs is a novel and surprising one, or because it is difficult to see how the animal could survive the operation, but because it assumes a condition of affairs that does not exist, because the peripheral nerves and the cross commissures present impassable barriers to the proposed changes, and because the suggestion is inconsistent with the most obvious facts of embryology.

In 1896 (*Nature*), about eight years after the idea first occurred to him, Professor Gaskell is led to suspect that there may be some difficulties in homologizing the hæmal surface of a crab with the neural surface of a vertebrate, and gives the following explanation:

The ontogenetic test appears to fail in two points:

(1) "That the nerve tube of vertebrates is an epiblastic tube, whereas, if it represented the old invertebrate gut, it ought to be largely hypoblastic.

(2) "The nerve tube of vertebrates is formed from the dorsal surface of the embryo, while the central nervous system of arthropods is formed from the ventral surface.

"With respect to the first objection, it might be argued, with a good deal of plausibility, that the term 'hypoblast' is used to denote that surface which is known by its later development to form the alimentary canal, that in fact, as Heymons has pointed out, the theory of the germinal layers is not sufficiently well established to give it any phylogenetic value." Are we to understand from this that since the canalis centralis does not develop into an alimentary canal, it is probably hypoblastic?

"The second objection appears to me more apparent than real. The nerve layer in the vertebrate, as soon as it can be distinguished, is always found to lie ventrally to the layer of epiblast which forms the

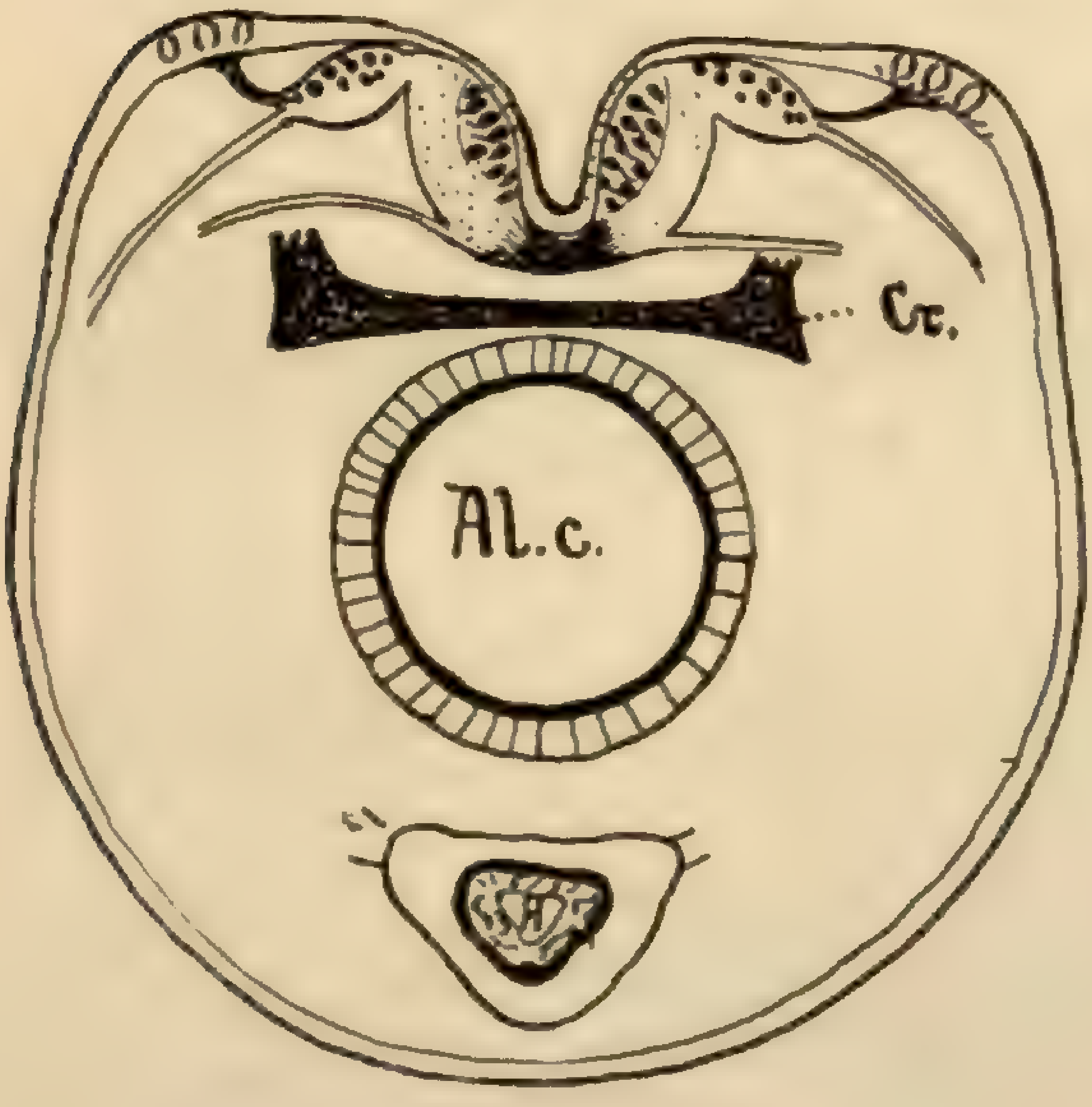

FIG. 3.

FIG. 4.

FIGS. 3, 4. — Cross-sections of a vertebrate in the head region, illustrating how the vertebrate condition may be attained by turning the arthropod over on to its dorsal surface, thus bringing its principal organs into the same relative position as in vertebrates. No degeneration of old organs or formation of new ones is required according to this view. The epithelium of the canalis centralis and ventricles thus appear not as parts of an old alimentary canal, but as the infolded ectoderm that from the first overlies the brain and spinal cord, and from which they are phylogenetically as well as ontogenetically derived.

central canal. . . . The nerve layer in the arthropod lies between the ventral epiblast and the gut; the nerve layer in the vertebrate lies between the so-called hypoblast (*i.e.*, the ventral epiblast of the arthropod) and the neural canal (*i.e.*, the old gut of the arthropod). The new ventral surface of the vertebrate in the head region is not formed until the head fold is completed. Before this time, when we watch the vertebrate embryo lying on the yolk, with its nervous system, central canal, and lateral plates of the mesoblast, we are watching the embryonic representation of the original Limulus-like animal; when the lateral plates of the mesoblast have grown round,

and met in the middle line to assist in forming the new ventral surface, and the head fold is completed, we are watching the embryonic representation of the transformation of the Limulus-like animal into the scorpion-like ancestor of the vertebrates."

It is not quite clear what Mr. Gaskell means by the above statement, but if I understand him correctly, it is clear that if the embryonic shield of a vertebrate embryo represents an arthropod embryo on the old arthropod hæmal surface, then the growing margins of the mesodermic area must lie *between* the nerve cords, and they should grow toward the mid-dorsal line and concresce there. But nothing of the kind is to be seen in vertebrates, because the mesoderm lies mainly *lateral* to the nerve cords, and grows in the opposite direction to what it should according to Gaskell's theory, namely, toward the vertebrates' true hæmal surface. Moreover, the transformation of the "Limulus-like animal into the scorpion-like ancestor" should show us not merely the growth of the mesodermic plates, but the migration of the canalis centralis and the nerve cords from their first position in the embryonic shield of a vertebrate (*i.e.*, the Limulus condition) to the opposite side of the egg, *i.e.*, the vertebrate position. But the nerve cords and canalis centralis are already in their permanent vertebrate position, and for that very reason, according to his own supposition, they cannot also be in the Limulus position! The reader may perhaps doubt whether Gaskell, in his earlier papers, thought that the alimentary canal of arthropods arose from the dorsal or the ventral surface of the egg. If he supposed it arose from the ventral surface between the nerve cords, then how can it appear in vertebrates at the very outset of development at the opposite side of the egg? Consultation of the text leads one to suspect that the difficulty is to be solved by taking the entire roof off the crab, leaving nothing but the ventral surface behind, for he also claims that in vertebrates the infolding of the medullary plate represents the simultaneous development of the nerve cords and alimentary canal of the ancestral crab, hence they must appear on what was the ancestral ventral side, so that we must suppose the medullary plate of vertebrates is seen through an imaginary dorsal portion of the ancestral crab, like the coat-tail buttons on the back of Marley's ghost; or, if he wishes to avoid this dilemma by an appeal to the tottering theory of concrescence, he will be forced to look on the vertebrate blastopore not as the original mouth of a remote ancestor, but as the entire dorsal surface and sides of a crab, into which are gradually swept all the organs which, in a crustacean, lie dorsal to the nerve cords and

alimentary canal. If Mr. Gaskell accepts this alternative, he will find it difficult to explain how the alimentary canal of the ancestral crab was split into two surface cords of cells that sweep round to the opposite side of the ovum to form the canalis centralis of vertebrates.

Gaskell bases his comparison of the pineal eye of vertebrates with the ocelli of arthropods mainly on their minute structure, neglecting their mode of development and the fact that there are two distinct types of arthropod ocelli, namely, the paired ocelli, with upright retinas, as in Dytiscus and Hydrophilus, and the ocelli with inverted retinas, formed by the fusion in the median line of two or more ocelli (*e.g.*, median ocelli of scorpions, Limulus, and possibly some crustacea). As we have shown elsewhere, the latter are the only ocelli that can be compared with the pineal eye of vertebrates, both on account of their position and the fact that they are the only ocelli which lie at the end of tube-like outgrowths from the roof of a cerebral vesicle. This condition is brought about in scorpions and in Limulus by the overgrowth of a lateral fold of ectoderm, which in the scorpion completely encloses the cephalic lobes or forebrain, leaving the inverted ocelli at the end of a tubular outgrowth of the roof of the vesicle. This is one of the most satisfactory indications we have of a relation between vertebrates and arthropods, for it shows us in detail how the eyes of vertebrates have in all probability been inverted and transferred from the lateral edges of the cephalic plate to the ends of tubular outgrowths of a cerebral vesicle. In Gaskell's earlier paper (*Quart. Journ.* p. 50, 1889) he compares the pineal eye of vertebrates with the ocelli of Dytiscus and Hydrophilus. He then constructs a diagram of the vertebrate pineal eye, which is almost an exact copy of the ocelli of Dytiscus, and this diagram is printed in three colors, to show that the pineal eye of vertebrates "is clearly that of an arthropod, and indeed of an ancient form" (p. 53, 1889). As a matter of fact, however, the ocelli of Dytiscus and the pineal eye of vertebrates are not in the least alike, and the mode of development in the two cases is entirely different. On the other hand, the median ocelli of scorpions and of Limulus do resemble in a most striking way, in their position and development, the pineal eye of vertebrates. These ocelli *already lie at the end of a tubular outgrowth from the roof of a forebrain vesicle.* These facts perhaps escaped Gaskell's attention, although they were described in the same number of the *Quarterly Journal* as his earlier paper. They are fatal to his view that the forebrain vesicle is a remnant of an arthropod alimen-

tary canal, because if the arthropod brain is already hollow, why should any one introduce the alimentary canal into it in order to explain why the brain is hollow in vertebrates?

I have described in the same number of the *Quarterly Journal* in which Gaskell's earlier paper appeared how the cartilaginous endosternite in scorpion and Limulus is comparable in shape and in its relations to the brain and alimentary canal with the primordial cranium of vertebrates, and how a complete ring is formed about the posterior part of the brain, like the occipital ring seen in the early stages of

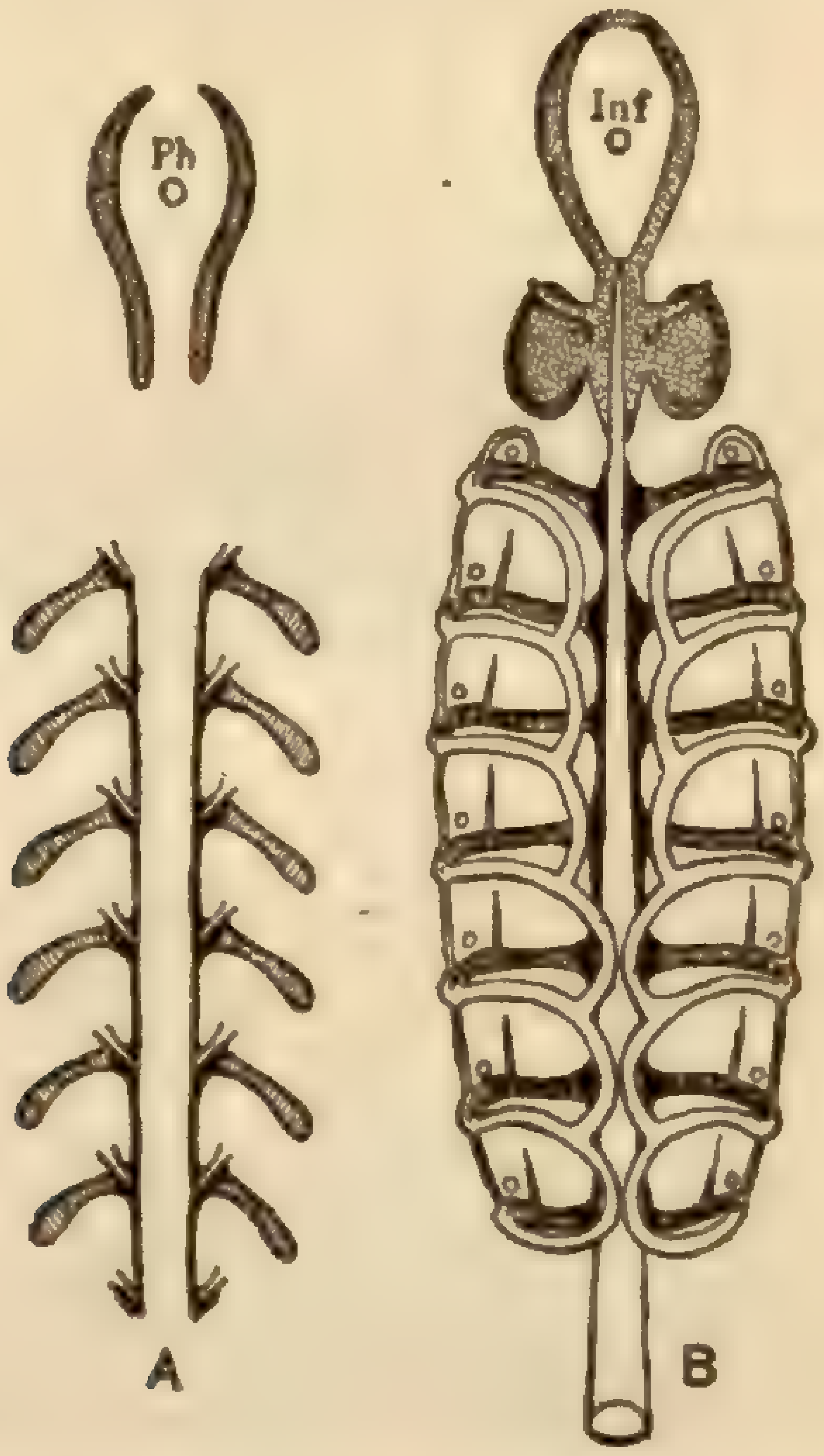

Fig. 5. — Gaskell's diagrams of the cartilages constructed by him to show how much the cartilaginous skeleton of Limulus, A, resembles that of Ammocœtes, B.

the cartilaginous cranium of vertebrates. Gaskell makes no reference to these facts, but nevertheless he lays great stress on the presence of the endosternite, although it lies on the opposite side of both the nervous system and the alimentary canal from what his theory demands. To meet the requirements of his theory, the endosternite must first be split in halves lengthwise, and the two parts transferred to the opposite side of the nervous system, and then, after their reunion, a new occipital ring must be formed on the opposite side of the sternite from the one where it actually is formed in the arachnids. (Compare Figs. 1 and 2.) And before all these changes could take place, the long fragments of the sternite would have to plough their way through the nervous system, beneath the epithelium of the cerebral vesicles and the canalis centralis (Fig. 1). But even then,

to get entirely out of the trap, they would have to break through either all the cranial nerves, if they passed out laterally to the nerve cords, or else all the cranial cross commissures, if they passed between them.

In order to make the similarity between the cartilages of Ammocœtes and those of Limulus more apparent, Gaskell produces two

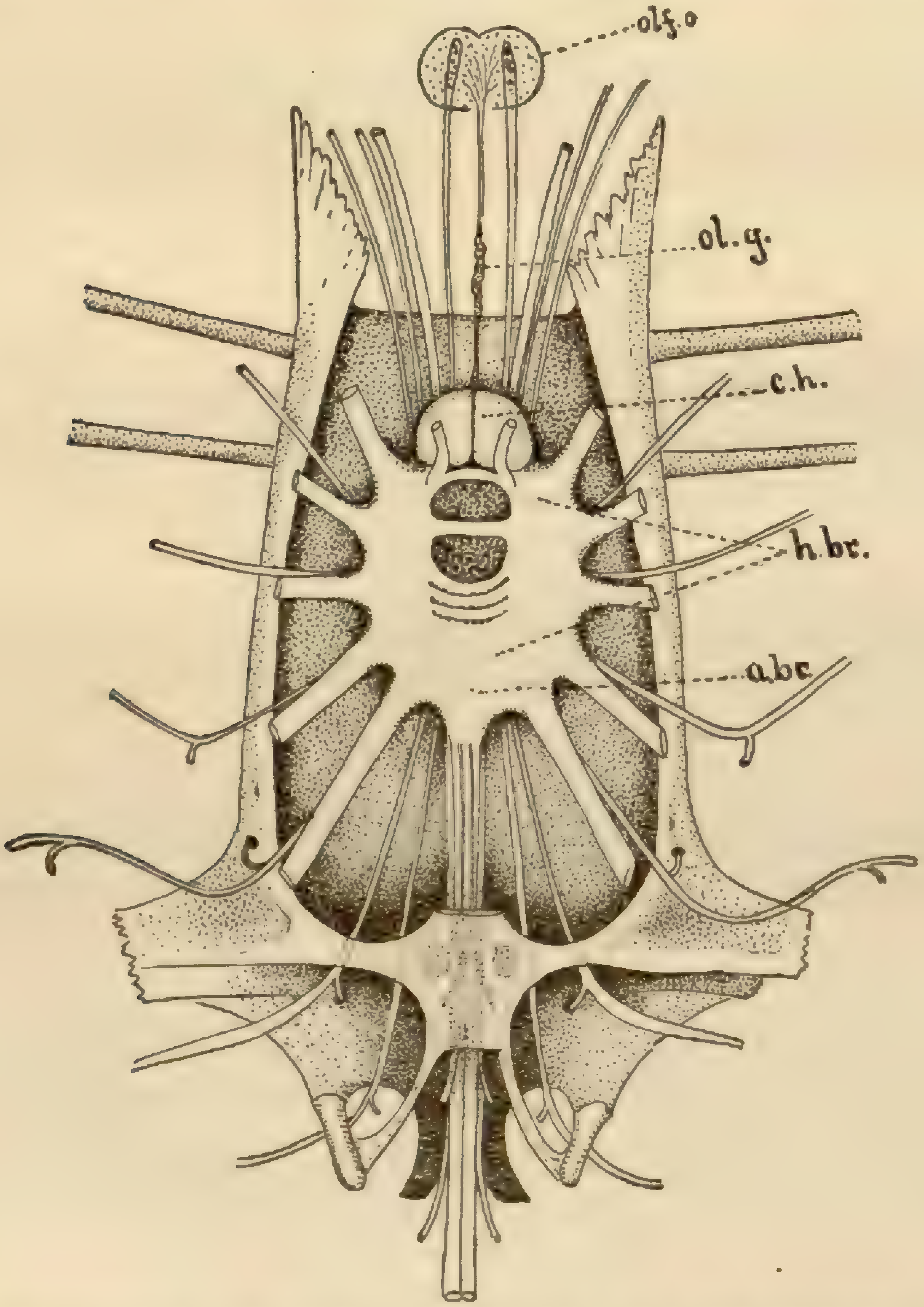

FIG. 6. — The endosternite of Limulus seen from the ventral side, with the brain and anterior part of the spinal cord in place, about natural size. The posterior part of the cranium is roofed over by a tough membrane, which on the sides gradually changes to the cartilaginous arches that help form the occipital ring, through which pass the spinal cord and several pairs of nerves. The sides of the cranium are perforated by two pairs of foramina, through which pass branches of the hæmal nerves. This cartilage is represented in Gaskell's diagram by the two bow-shaped cartilages on either side of *Ph*.

diagrams side by side (*Journal of Anatomy and Physiology*, Vol. XXXII, p. 556). One is a diagram of the cartilaginous skeleton of Ammocœtes, the other is labeled a "diagram of the cartilaginous

skeleton of Limulus" (Fig. 5 A). The diagrams do resemble each other very much no doubt, but the Limulus diagram can hardly be regarded as an accurate representation of the cartilages of that animal, as may be seen by comparing it with a drawing made directly from the object itself (Fig. 6). This figure is copied from one in a paper about to be published by Mr. Redenbaugh and myself, on the cartilages of Limulus, Apus, and Mygale. It is not easy to account for the construction of Mr. Gaskell's extraordinary diagram, since the endosternite of an adult Limulus is, roughly, two inches wide by three inches long, and several millimeters in thickness, a single heavy plate of tough cartilage, not readily broken or distorted. It has, moreover, been repeatedly figured and described, and Gaskell has himself dissected it and studied its histological characters.

Papers like the ones we have just reviewed are unfortunate. They are not a credit to the science of comparative morphology, and the interest in the whole subject of the origin of vertebrates suffers from the reaction induced by such efforts.

William Patten.

Hanover, N. H.

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STUDIES ON REACTIONS TO STIMULI IN UNICELLULAR ORGANISMS.

H. S. JENNINGS.

III. REACTIONS TO LOCALIZED STIMULI IN SPIROSTOMUM AND STENTOR.

IN the second of these studies (*American Journal of Physiology*, May, 1899) the writer has given an account of the mechanism of the reactions of Paramecium that involves an entirely different conception of the nature of these activities from that which has been generally assumed. It was shown that this protozoan has but one motor reaction in response to the most varied stimuli, and that it reacts without any relation whatever to the position of the stimulating agent, so that it cannot be said to be attracted or repelled by any agency or condition — its reaction being strictly comparable in all essentials to that of an isolated muscle. The importance of this, in case it should turn out to be the general method of reaction for unicellular organisms, is obvious, involving, as it does, the rejection of almost all hitherto received theories of the mechanism of reactions; the question, therefore, immediately arose as to whether this method of reaction was to be extended to other Protozoa. The following study of the reactions of Spirosto-

mum and Stentor is presented as a contribution toward answering this question.

The minute size of Paramecium brought with it the great disadvantage that it was not possible under experimental conditions to apply localized stimuli to definite parts of the body, so that recourse was necessary to observation of chance contacts of sources of stimuli with one or another part of the body; an unsatisfactory method, and one requiring much time and patience. This difficulty is obviated in *Spirostomum ambiguum* and *Stentor polymorphus*, which are both so large that there is no difficulty in applying stimuli to any desired region on the surface of the body. The simplest means of doing this is to touch any point on the surface of the body with a proper instrument, thus giving the animal a sharply localized mechanical stimulus. Other methods are given in the following account of observations.

Spirostomum ambiguum (Fig. 1).

Spirostomum ambiguum is one of the largest of unicellular animals, reaching a length of two or three millimeters. The average length of those on which the following observations were made was about one and one-half millimeters. In form Spirostomum is a long, slender cylinder of nearly equal diameter throughout, but slightly smaller at the ends. The mouth lies behind the middle of the body, and from this a band of large cilia (the adoral zone) runs to the anterior end of the body. The large contractile vacuole lies at the posterior end, and from this a canal runs almost the entire length of the body near its aboral side, or curving a little onto the right side. The adoral zone and this canal form important landmarks for determining directive relations in studying the movements of the animals. The posterior end is truncate, while the anterior end is rounded and shows a difference in its contour on the two sides of the animal. The tip is curved slightly toward the side on which the mouth is situated (the oral side), so that on the opposite or aboral side the contour is a long convex curve, while on the oral side there is almost an angle. These facts are best

appreciated in the figure; while not prominent, they are visible, and are of the greatest importance for orientation while studying the movements of the animal. The difference in the two contours of the anterior end possibly does not correspond precisely to the distinction between the oral and aboral sides, as determined by the position of the mouth; the exact relation of parts is very difficult to determine on account of the continual twisting movements of the animal. But the difference in contours in any case marks very nearly the oral and aboral sides, so that when the aboral side is spoken of in the following account it signifies that side of the anterior end in which the curve is longest, while the oral side is that which presents the shortest curve (see Fig. 1). The entire surface of the animal is covered with cilia, arranged in somewhat oblique longitudinal rows.

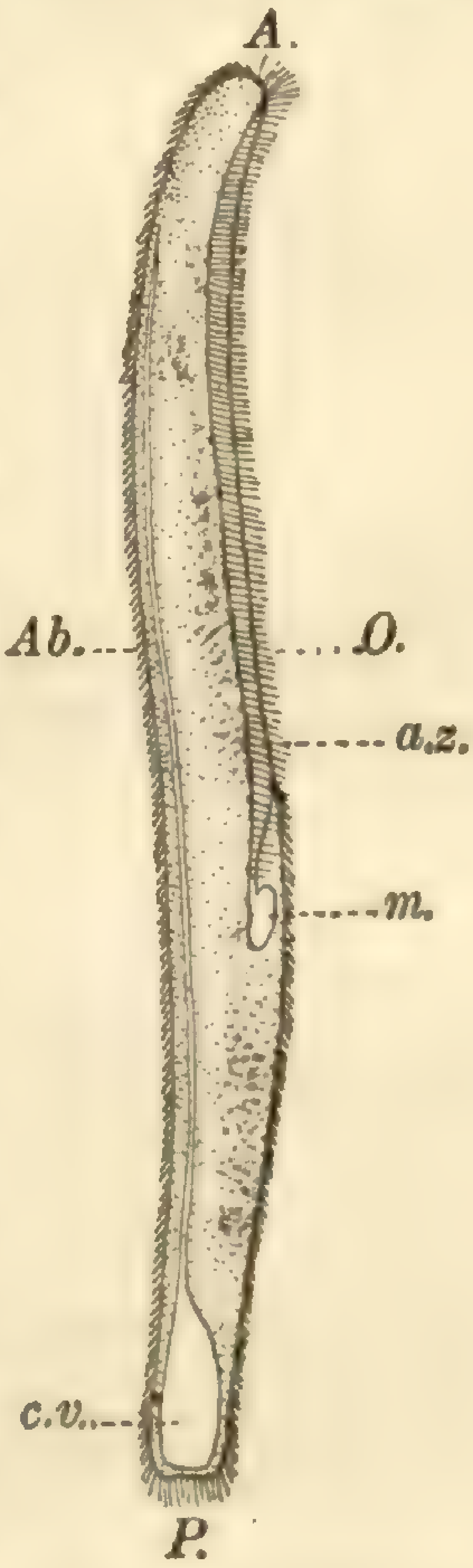

FIG. 1. — *Spirostomum ambiguum*, right side. *A*, anterior end; *P*, posterior end; *O*, oral side; *Ab*, aboral side; *a.z.*, adoral zone; *m*, mouth; *c.v.*, contractile vacuole.

The unstimulated Spirostomum swims forward by means of the backward stroke of its cilia; at the same time it may revolve on its long axis. This revolution is usually from right to left. The body (as shown in Fig. 1) is not quite straight, but a little in front of the middle is slightly bent, so that the anterior part, as the body revolves, describes the surface of a cone. Owing to the animal's continual movement and its power of twisting into a spiral and of bending sharply, taken in connection with the only slight differentiation on the surface of the cylindrical body, the orientation of the body in relation to the direction of movement is very difficult to determine. But by keeping the attention fixed upon the form of the anterior end, as described above, it is possible under favorable conditions to observe that the aboral side of the anterior end is always on the outside of the cone, the oral side looking within. As the animal moves forward in connection with this revolving motion,

the path of course becomes a spiral; it agrees exactly with the path of Paramecium, in that the aboral side always looks toward the outer side of the spiral. At times the animal swims some distance without revolving on its long axis; at such times the path is not a spiral.

We will now proceed to a systematic examination of the changes in motion due to stimuli of different sorts and applied at different points on the animal's body.

A. *Mechanical Stimuli.*

The method of study consisted in touching with a capillary glass rod, of less diameter than the animal's body, different points on the surface of the animal, and noting the reactions caused. This procedure presents no difficulties.

1. *Stimulus at Anterior End.* — If the animal is touched at the anterior end with the tip of the glass rod, it immediately contracts strongly, becoming short and thick, and the zones of cilia forming spirals surrounding the body, in the manner well known. (See the figure given by Bütschli in *The Protozoa of Bronn's Klassen und Ordnungen des Thierreichs*, Taf. LXVII, Fig. 2 *b*.) At the moment of contraction it darts backward a little. It then gradually extends, continuing to swim backward. As it swims backward it revolves on its long axis, in all cases observed, from right to left, in the same direction as when swimming forward. Next it begins to turn its anterior half to one side, usually at the same time beginning to swim forward. Like Paramecium, it always turns toward the aboral side of the anterior end. It usually revolves at the same time, so as to describe a very wide spiral, with the aboral side on the outside of the spiral, finally straightening out and swimming forward in the direction indicated by the position of the aboral side at the time it straightens. Briefly, the animal when stimulated at the anterior end contracts, backs off, turns to the aboral side, and swims forward on a path which lies at an angle to the path on which it was previously swimming. In the case of a very slight stimulus the contraction may be omitted, the rest of the reaction being given as usual, ex-

cept that the animal swims only a short distance backward before turning.

2. *Stimulus at Posterior End.*—If now the animal is touched at the posterior end, exactly the same reaction is produced. It contracts, then swims backward, — therefore toward the point of stimulus (whereas in the other case it swam away from the point of stimulus). Then it curves toward the aboral side, describing a wide spiral, and finally swims forward in the direction of the aboral side, exactly as described above. It makes no difference to the reaction which way the animal is swimming when stimulated: if swimming forward, the direction is changed; if swimming backward when touched at the posterior end, it continues to swim backward after contracting.

The posterior end is slightly less sensitive than the anterior, so that a very weak stimulus at the posterior end may cause no reaction at all. No matter where stimulated there are rare cases in which the animal when stimulated merely contracts (always darting back a little at the moment of contraction), then stops for a time, then resumes a forward motion. Out of one hundred cases stimulated at the anterior end, ninety-six reacted in the typical manner, while four gave the incomplete reaction just mentioned. Out of one hundred cases stimulated at the posterior end, ninety-two gave the typical reaction, while eight reacted incompletely. This difference in the number giving the typical reaction is probably a mere statistical variation, which would disappear with larger numbers; if any significance is to be attached to it, it is merely that already noted — that the posterior end is slightly less sensitive than the anterior.

The reaction is thus exactly the same whether the stimulus occurs at the anterior or the posterior end.

3. *Stimulus at One Side.* — When the animal is touched anywhere on the surface of the body between the two ends, the same reaction is given as in the two foregoing cases; the animal contracts, swims backward, curves toward the aboral side, and swims forward toward that side. The final direction in which it swims bears no relation to the position of the side on which the stimulus was given.

4. *Stimulus Unlocalized.* — An unlocalized mechanical stimu-

lus can be given by jarring the dish or slide containing the animals. They contract, swim backward, turn toward the aboral side, and swim forward, exactly as in the other cases.

Thus the reaction given by Spirostomum to a mechanical stimulus is identically the same, whatever part of the body is stimulated, or even if the stimulus is not localized at all. A diagram of the reaction of Spirostomum to a stimulus is given in Fig. 2.

5. *Repeated Stimuli.* — When the same animal is repeatedly stimulated, certain features in the reaction are especially worthy of notice. At the first stimulus the animal contracts, then

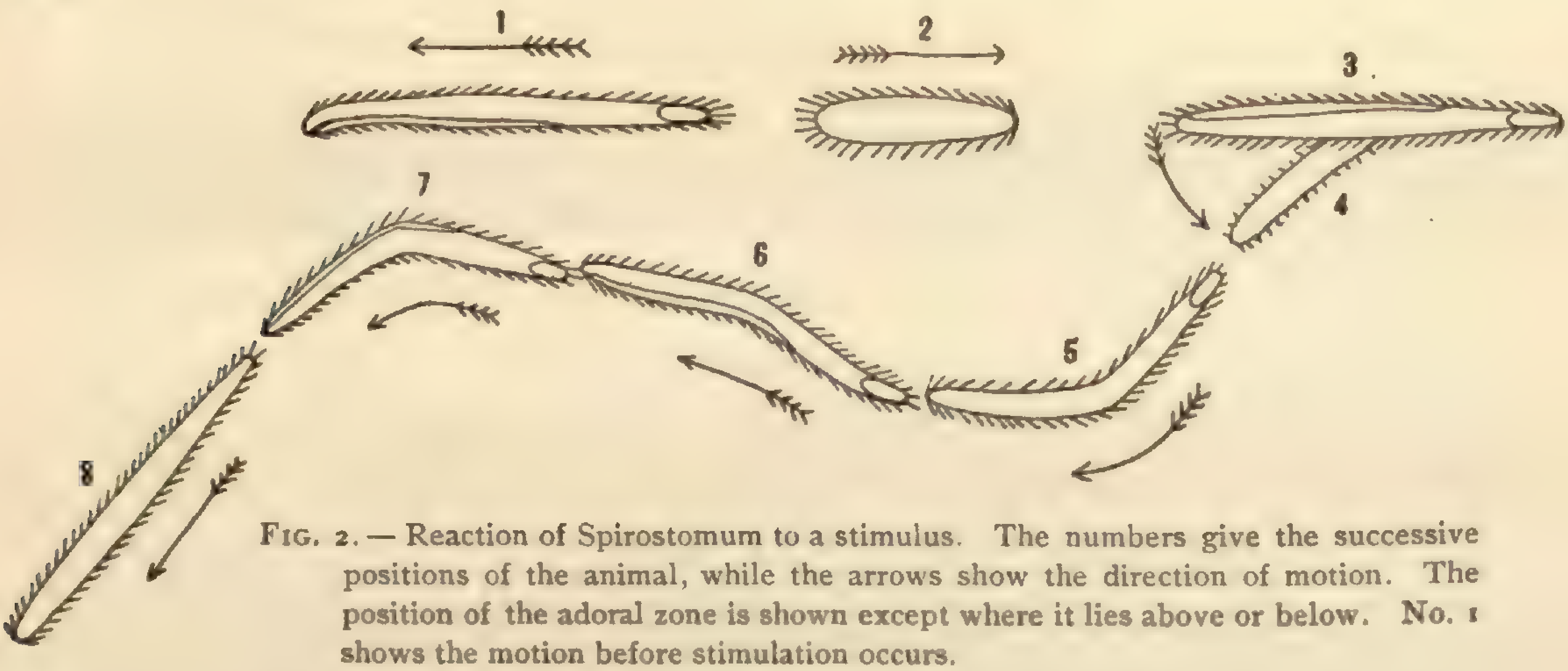

FIG. 2. — Reaction of Spirostomum to a stimulus. The numbers give the successive positions of the animal, while the arrows show the direction of motion. The position of the adoral zone is shown except where it lies above or below. No. 1 shows the motion before stimulation occurs.

swims backward. Now if, after recovering from the contraction, but while still swimming backward, it is again stimulated, it again contracts and continues to swim backward. On a third stimulation, while still swimming backward, it usually *reverses* its course and swims forward. A reversal of the direction of motion now usually occurs at each new stimulus up to four or five. This reversal at each new stimulus may easily give the impression that the animal is swimming each time away from the source of stimulation, and hence that it is reacting with relation to the localization of the stimulus; but this appearance is due merely to a psychological peculiarity of the experimenter. It is natural for the experimenter to touch the animal at the end toward which it is moving — to "head it off" as it were. On the third trial he will, as above stated, usually succeed in getting it to reverse its motion and swim in the opposite direc-

tion. He then "heads it off" again by touching the other end toward which it is now swimming, with the result that it reverses again. This alternation on the part of experimenter and infusorian may continue for a number of times, giving the impression that the animal is clearly reacting with reference to the position of the source of stimulus, fleeing from it in each case. But this alternation is really an independent phenomenon in each of the two organisms concerned in the experiment, as is proved by the following. If the experimenter continues to stimulate the animal at the same end, regardless of the direction in which it is moving, the animal's direction of motion will alternate as before. Thus, after the second stimulation, while the Spirostomum is swimming backward, if stimulated at the anterior end, it will now swim forward or toward the source of stimulus; if stimulated again at the anterior end, it will reverse and swim backward; again, and it swims forward once more. In these cases, as in the others, therefore, the direction of motion has no relation to the localization of the stimulus.

If the stimulations are continued after five or six times, the animal will continue to swim violently in one direction or the other, without regard to the repetition of the stimulus or its localization. It is thus possible to stimulate the animal repeatedly at its posterior end while it is swimming violently to the rear, and thus toward the source of stimulus; in other cases it swims as violently away from the stimulus. In no case does the position of the stimulus have any effect on the direction of motion.

B. *Chemical Stimuli.*

It is easy to localize the action of chemical stimuli in the following manner. A capillary glass rod is coated with paraffin. A crystal of NaCl or other salt is then attached to the rod by means of the paraffin coating, and can then be held near to any part of the animal's body.

1. *Stimulus at Anterior End.* — The crystal of NaCl is held close to the anterior end of the Spirostomum, but without touching it, so that only the diffusing salt in solution comes in contact with the animal. The Spirostomum contracts, swims

backward (away from the source of stimulus), turns toward the aboral side, and swims forward, exactly as in the case of a mechanical stimulus.

2. *Stimulus at Posterior End.* — The crystal of salt is held close to the posterior end. The animal contracts and swims backward — therefore *toward* the source of stimulus. It thus either strikes the crystal of NaCl or passes through the densest part of the solution; then continues backward some distance, finally turning toward the aboral side and swimming forward.

3. *Stimulus at the Side.* — The animal reacts as in the two preceding cases, the direction of motion having no relation to the position of the stimulus.

4. *Stimulus Unlocalized.* — The Spirostoma are dropped directly into 2 per cent NaCl. They contract, swim backward, turn about irregularly, and soon die.

The following experiment, giving results in almost all the above categories, is particularly striking. A number of Spirostoma are placed on a slide in a considerable quantity of water. Then a few crystals of NaCl are placed in the center, the cover-glass quickly supplied, and the reactions of the animals noted. All those in the immediate neighborhood of the NaCl soon contract and swim backward, as the flood of salt solution diffusing from the crystals comes against them. The Spirostoma are scattered, with axes oriented in no special direction, therefore some lie with anterior ends directed toward the mass of salt, so that this end first comes in contact with the salt solution; others with posterior end thus directed; others with long axis oblique to the direction of the mass of salt. All contract and swim backward, whatever part of the body is first met by the diffusing solution of NaCl. Those with anterior ends directed toward the mass, swimming backward, of course move directly away from the salt. Those with posterior end toward the salt, likewise swimming backward, pass directly into the densest part of the solution of NaCl, and are quickly plasmolyzed and killed. Those with long axis oblique to the direction of the NaCl also swim backward, some thus approaching more or less obliquely the solution of NaCl; these do not turn,

but swim straight on, crossing the area and coming out on the other side, unless plasmolyzed and killed during the passage.

It is evident that the Spirostoma are neither attracted nor repelled by the NaCl; it merely sets in operation their one reaction, and this takes them into danger or safety as chance may direct. Under normal conditions, of course, the anterior end will usually be directed toward the stimulating agent, since the animal generally swims forward, and masses of dangerous chemicals are not often dropped suddenly into the midst of a group of the Infusoria; hence the device of swimming backward usually saves the animal. The following curious experiment shows how possibly a combination of circumstances might arise even under normal conditions such that the reaction would result in the destruction of the animal. A small mass of NaCl was slowly dissolving in the center of the slide. A Spirostomum was swimming forward directly away from the diffusing salt, not being in the region of its influence at all. Its posterior end was thus pointed toward the salt, but as it was swimming away it was in no danger. Now a slight jar was given to the preparation — such as might easily occur in nature. Thereupon the Spirostomum reacted in the usual manner, by contracting and swimming backward. It thus swam toward the NaCl, until finally its posterior end came in contact with the advancing flood of salt solution. Thereupon the customary reaction was again induced still more powerfully; the animal contracted and swam still more swiftly backward; thus entering the salt solution, it was plasmolyzed and killed.

When a Spirostomum swimming forward comes in contact with a diffusing chemical, it contracts, darts backward, then swings its anterior end about, finally turning toward the aboral side and swimming straight forward — so long as this does not take it again into the region of the stimulating agent. If it does, the reaction is repeated until by the laws of chance the Spirostomum is directed into a region which does not cause stimulation. If the stimulus with which the anterior end comes in contact is very weak, the animal may omit the contraction and move a little backward without contracting; then the anterior end is swung about in a circle (the aboral side, of course,

toward the outside of the circle), while the animal starts forward. So long as the anterior end is thus carried into a medium which causes the weak stimulus, the forward movement is at once checked and the animal jerks backward again; as soon, however, as the anterior end in its circling comes into a direction such that swimming forward does not carry the animal into a region causing the reaction, the animal continues to swim straight forward. All these facts find a precise parallel in the reactions of Paramecium.

When the Spirostomum is swimming backward, the course is never changed by the circling about of the posterior end and the turning in one way or another, as it is when the anterior end is directed forward; the posterior end seems to have no power of initiating a turning movement. In this connection the reactions of the separate parts of a Spirostomum, cut into two or more pieces, is of interest.

C. *Reactions of Separated Parts.*

There is no difficulty in cutting Spirostomum with scissors or scalpel transversely into short pieces. Any piece with which the anterior end remains in connection, though it be but one-tenth of the entire animal, reacts in essentially the same way as the entire organism — by contracting, swimming backward, turning and swimming forward. Its motion, perhaps, differs a little in degree from that of the entire animal in the fact that turning is more frequent and pronounced, the piece at times swimming in a small circle. The direction of turning is, as in the uninjured specimen, toward the aboral side. Any piece from which the anterior end is separated, while the posterior end is uninjured, reacts as follows. When stimulated, it contracts and swims backward, *does not turn*, but soon swims forward. It swims but a short distance forward, then starts backward again; after going in this direction once or twice its own length, it swims forward about the same distance; then again backward. It continues thus to oscillate back and forth indefinitely. When the anterior end is removed, therefore, the motion takes the form of a rhythmical back and forth move-

ment. This is true when the posterior piece comprises as much as nine-tenths of the entire animal.

It seems, therefore, that the power of initiating a turn, and the power of continuing a course once begun, are localized in some way in the anterior end.

Stentor polymorphus (Fig. 3).

Stentor polymorphus is smaller than *Spirostomum ambiguum*, but is still of sufficient size to make the application of localized stimuli a matter of no difficulty. It is a trumpet-shaped animal, exceedingly changeable in exact form and proportions. Fig. 3 shows a usual form of the animal when swimming freely; when anchored by its base the form is more extended and slender. The surface of the animal is covered with cilia in longitudinal rows, while the broad anterior end, known as the peristome, is surrounded by a circle of larger cilia forming the adoral zone. At one side of the disk is a funnel-like depression which leads into the mouth. That surface of the body nearest to which the mouth lies may be called the oral surface; the opposite one, the aboral surface. Considering the oral as equivalent to ventral surface, we may define right and left sides as follows: When the oral surface is below, and the anterior end is away from the observer, the right and left sides of the animal correspond to the observer's right and

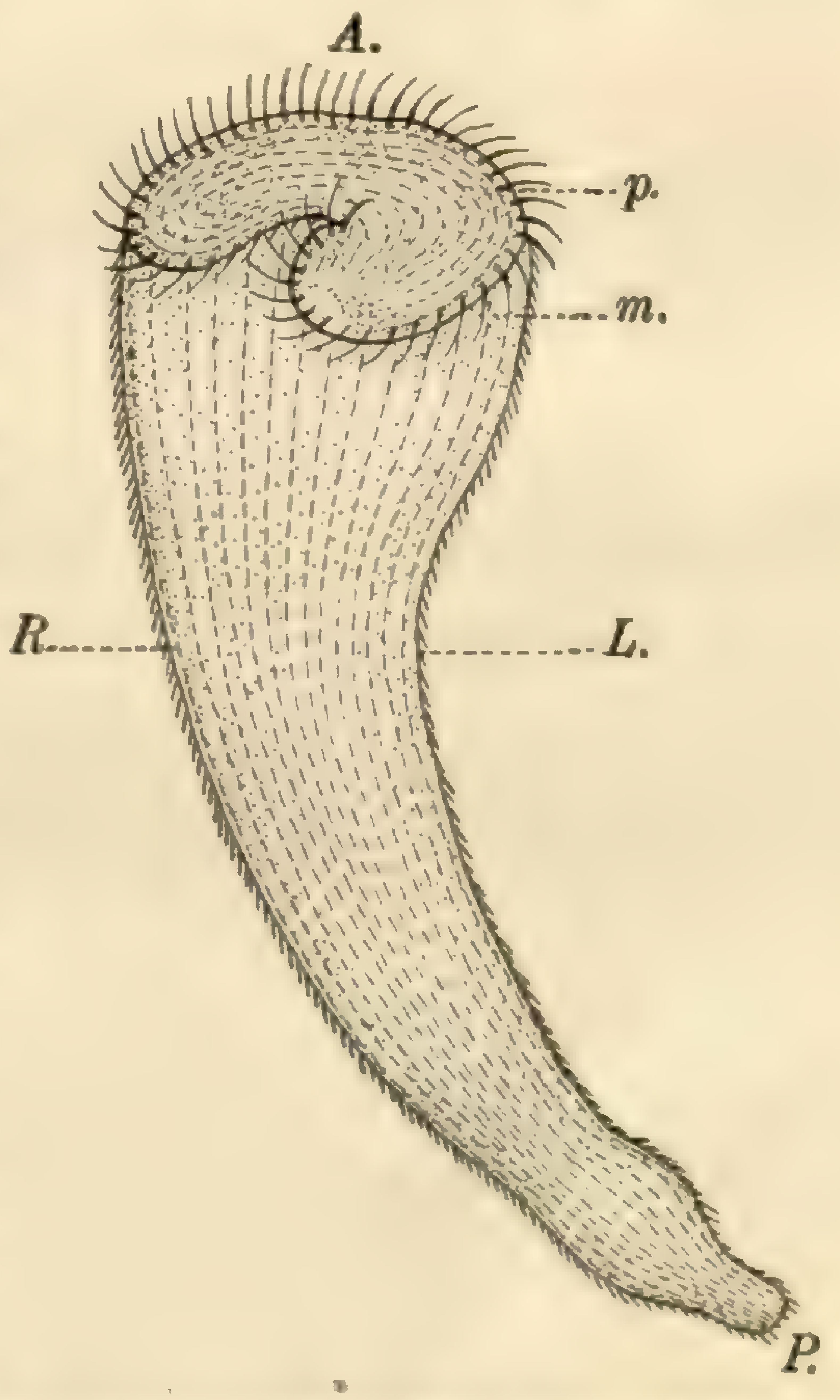

FIG. 3.—*Stentor polymorphus*, partially contracted free-swimming individual, oral surface. *A*, anterior end; *P*, posterior end; *L*, left side; *R*, right side; *m*, mouth; *p*, peristome.

left. (In the figure the oral surface is above, so that right and left sides are reversed.) The body of the animal is usually curved, being bent from the direction of the anterior end toward the left side; sometimes there is near the posterior end a second short curve to the right.

Stentor polymorphus is often found attached by its posterior end; at other times it swims freely in the water. The motion in the free-swimming individuals is as follows: The animals swim slowly forward; at the same time they may or may not revolve on the long axis. The revolution when it occurs is usually, if not invariably, to the left. When the animal swims forward without revolving on its long axis, the path is usually a curved one, the animal continually swerving toward its right side. In this way the Stentors usually describe circles of greater or less radius. If they revolve as they swim forward, they continually swerve to the right also; but owing to the revolution, the right side continually changes its position, so that the path becomes a spiral one, as in Paramecium and Spirostomum. The motion of *Stentor polymorphus* is usually very slow, so that all these relations are observable without the slightest difficulty.

A. *Reactions to Mechanical Stimuli.*

The animals were stimulated in the same way as Spirostomum, by touching them at any desired point with a capillary glass rod.

1. *Stimulus at Anterior End, on Peristome.*—The animal contracts and swims backward a short distance (its own length or a little more). As it swims backward it revolves on its long axis to the left — in the same direction as when swimming forward. Then it turns on its short axis to its right and swims forward.

2. *Stimulus at Side.*—Identically the same reaction is given as when stimulated at the anterior end; the animal contracts, swims backward, turns to right, and swims forward. The turning is not with reference to the position of the source of stimulus, but is always toward the right side. Therefore, if

stimulated on the right side, the animal turns toward the side stimulated; if on the left side, it turns away from the side stimulated. Owing to the revolution on the long axis while swimming backward, the position of the right side at the time of turning on the short axis bears no definite relation to its position at the time of stimulation; so we find that the absolute direction toward which the animal turns has no constant or prevailing relation to the absolute direction from which the stimulus came.

3. *Stimulus at the Posterior End.* — The posterior end of Stentor, narrowing to a point of attachment, is very little sensitive, so that touching it with the rod of glass usually causes no reaction whatever. By giving it a smart blow, however, a reaction can be induced, and this is then identical with the reaction already described. The animal thus, of course, swims at first *toward* the source of stimulus.

4. *Stimulus not Localized.* — If the vessel containing the Stentors is jarred, they react in the same manner as to localized stimuli.

B. *Chemical Stimuli.*

Stentor gives the same reaction to chemical as to mechanical stimuli. If when swimming forward through the water it comes

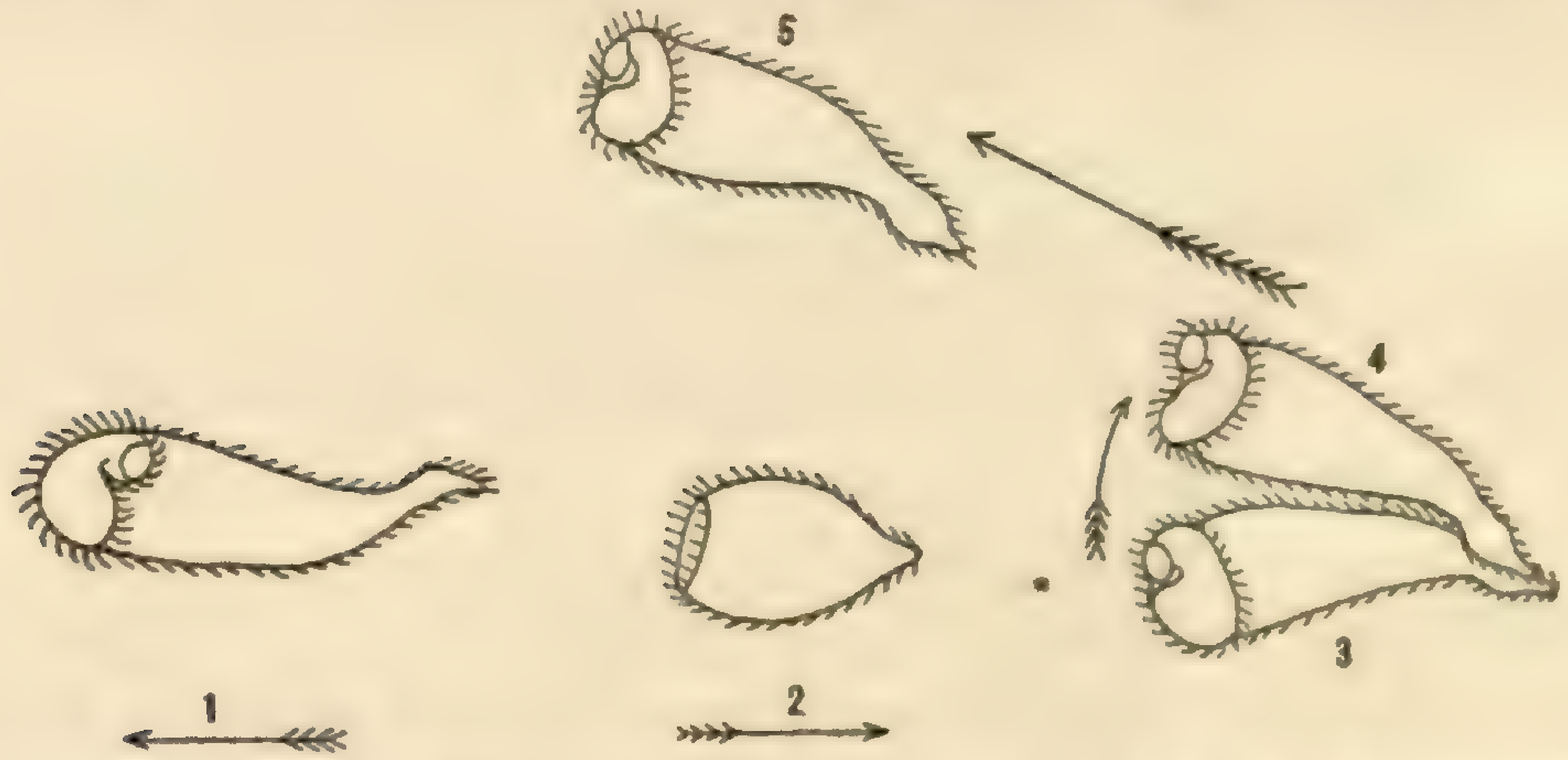

Fig. 4. — Diagram of the reaction of Stentor. The arrows show the direction of motion, while the numbers indicate the successive positions of the animal; No. 1 showing the animal before stimulation occurs.

in contact with a chemical substance sufficiently powerful to act as a stimulus, it contracts, swims backward, turns to the

right, and swims forward on a new path; if this path takes it again into the stimulating region, the reaction is repeated; thus by the laws of chance the animal will in time probably be brought into a region which does not act as a stimulus. The reaction is the same whether the stimulus is localized or is a general one. The reaction is in essentials like that of Paramecium and Stentor.

The reaction of *Stentor polymorphus* is shown in Fig. 4.

Summary and Conclusions.

The reactions of Spirostomum and Stentor are similar in all essentials to those of Paramecium. To any stimulus all these animals respond by swimming backward, turning to one side, and then swimming forward. Paramecium and Spirostomum always turn toward the aboral side; Stentor, toward the right side. In Spirostomum and Stentor a contraction of the body forms an additional feature of the reaction. The reaction is not modified in any way by the position of the stimulus; the direction of motion is the same whether the source of stimulus is at the anterior end, the posterior end, the side, or if the stimulus is not localized at all. If the stimulus is at the anterior end, the animal necessarily swims away from it; if at the posterior end, it swims toward it, even when this results in the destruction of the animal. The discussion and conclusions given in my previous paper (*loc. cit.*) in regard to Paramecium are, therefore, equally applicable to Spirostomum and Stentor, and need not be repeated here.

The fact that three such dissimilar ciliates as Paramecium, Spirostomum, and Stentor agree in their reaction in all essential particulars certainly raises a presumption that the mode of reaction is of this general character throughout the ciliate Infusoria. This is especially probable in view of the fact that the revolution on the long axis and progress in a spiral course, which plays so essential a part in these reactions, and indeed seems to have the special purpose of making such a method of reaction possible, is already known to occur in the motions of almost all ciliates. Moreover, the same is known, through the

researches of Nägeli, to be true of the flagellate swarm spores of plants. According to this investigator, such swarm spores swim in a spiral course, with the same side always toward the outside of the spiral — exactly as I have described for Paramecium, Spirostomum, and Stentor. Another observation of Nägeli renders it extremely probable that the mechanism of the reactions of these organisms is essentially the same as in the three ciliates named. When these flagellate swarm spores strike in their forward course against an object, they cease the forward motion for a time, but continue to turn on the long axis; then "there ensues a backward motion, with posterior end in advance, while at the same time they rotate in the opposite direction. This backward course usually lasts but a short time and becomes gradually slower; it is soon exchanged for the forward motion, which takes place, as a rule, in a somewhat different direction from the original one." [1] This description would apply without the slightest change to the reactions of Paramecium, Spirostomum, and Stentor under the same circumstances. It may be predicted with much confidence that the reactions would be found to be similar under other circumstances; that the "somewhat different direction" of the swarm spores would be found to be always toward the side which faces the outside of the spiral course, and that the same reaction would be given whatever the nature and position of the stimulus. If this is true, then the conclusions which I have drawn for Paramecium in my previous paper would apply equally to the Flagellata. Certainly until the mechanism of the reactions of these and other unicellular organisms is determined by observation, it is hardly worth while to base any conclusions on theoretical schemes of the character usually given for such reactions. Theories of the reactions of unicellular organisms may be placed in two general classes: on the one hand are those theories which look upon the activities of unicellular organisms as determined in a manner similar to those of human beings, by a play of desires, motives, etc.; while at the other extreme are theories in which the movements are looked upon as of a character essentially similar to those taking place

[1] The above quotation from Nägeli is translated from Hertwig, *Die Zelle*, p. 66.

in a chemical reaction—the protoplasmic mass reacting rather as a substance than as an individual. Some such theory as this latter seems to be latent in the minds of many biologists; it finds typical expression in the scheme for the reactions of a unicellular organism to chemical substances given by Le Dantec (*La Matière Vivante*, pp. 50–54). In this scheme, which is illustrated by geometrical constructions and almost takes the form of a mathematical demonstration, Le Dantec assumes that there is a tension between the chemical in solution and the surface of the protoplasmic mass, and that this tension acts in lines of force directed either away from the center of the protoplasmic mass, or toward that center. The movement of the organism is then due to the difference in this tension on the two sides of the protoplasmic mass—that directed toward the center from which the chemical is diffusing, and that directed away from it. As the chemical diffuses from a center, the solution is less intense the farther one passes from the center; hence the solution is less dense on that side of the protoplasmic mass farthest away from that center. Assuming that the tension caused by the chemical acts on the protoplasmic mass in lines of force directed away from the center of the mass, it is mathematically demonstrable that this force will be stronger on the side toward the center of diffusion of the chemical, and that the resultant of all the lines of force will be a force directed exactly toward this center of diffusion. Hence the protoplasmic mass will move toward the center of diffusion of the chemical; in this way positive chemotaxis is explained. If, on the other hand, the tension acts in lines of force directed toward the center of the protoplasm, the same mathematical construction shows that the mass will move away from the center of diffusion; thus is explained negative chemotaxis.

The impossibility of reconciling the movements of the three Infusoria, whose reactions I have described, with any such theory as this is manifest. The theory, though designed expressly to explain the movements of the bacteria and flagellates used in Pfeffer's well-known experiments in chemotaxis, neglects entirely the fact of the differentiation, in those organisms, of axes along which movement takes place, as well as the fact that

they move by means of definite organs of locomotion, — flagella, or cilia. To make this abstract scheme fit the concrete motions of the organs of movement would be much more difficult than to invent the scheme.

If chemotaxis acts in the direct manner supposed in such a theory as the above, the organism will of course move directly toward a source of attractive stimulus, directly away from a source of repellent stimulus, and that moreover without regard to the relation of the direction of its axes to the direction of motion. As I have shown in detail for Paramecium (*loc. cit.*), and briefly above for Spirostomum and Stentor, this is by no means true for the organisms studied. On the contrary, the direction of motion has no relation to the position of the source of stimulus, so that we cannot correctly speak of attraction or repulsion at all. The organism reacts *as an individual, not as a substance*, and the nature of the reaction is conditioned by the internal mechanism and the structural differentiations of the body of the organism. The essential distinction insisted upon by Le Dantec (*loc. cit.*) between the reactions of a unicellular organism and those of a metazoan must therefore, for these organisms at least, fall to the ground. It will not do to think of the reactions of these organisms as in any way akin to those of chemical substances.

On the other hand, the reactions are equally distant from the complexity assumed by those who attribute to unicellular organisms most of the psychological powers of higher animals. The reactions of these organisms may best be compared with the working of a machine in which the wheels are geared to turn in but one direction, whatever be the nature of the force that sets them in motion.

Dartmouth College, Hanover, N.H.,
February 28, 1899.

VACATION NOTES.

II. The Northern Pacific Coast.

DOUGLAS HOUGHTON CAMPBELL.

The traveler journeying by rail from northern California into Oregon soon finds himself in a very different country from that which he has left to the south. On emerging from the densely wooded canyon of the upper Sacramento, the railroad climbs up to a nearly level plateau, from which rises the great cone of Shasta. The plain is almost destitute of trees, and presents much the appearance of the prairies east of the Rockies. The slopes of the mountains are well wooded, and the deep valleys between the ridges support a heavy growth of timber. The railway skirts the base of Shasta for several hours, and affords admirable views of the mountain from nearly all sides. Finally the Siskiyou Mountains, the boundary between California and Oregon, are surmounted, and the train descends rapidly into the fertile, well-watered valleys of Oregon. Flourishing fields of grass and clover, and apple orchards remind one of the eastern states, and replace the vineyards and prune orchards, or the fields of alfalfa, of central California.

Following the great Willamette valley, we finally reach Portland, and a few more hours bring us to Tacoma, whence our steamer sails for Alaska. Before Portland is reached, the great Douglas fir begins to predominate in the forest, and about Puget Sound often almost entirely makes up large tracts of forest. Here, too, it reaches its greatest dimensions, it being claimed that about the base of Mt. Rainier there are trees over 400 feet in height. As this is the staple timber tree of the northwest, most of the trees have been cut away from near the settlements, and one must go some distance away to find the virgin forest. This tree, fortunately, like many other western conifers, grows up quickly after the forest has been cut

over, and is rapidly taking possession of the cleared ground, where this has been left for a short time, so that the renewal of this most valuable timber ought not to be a difficult problem, and with little care a supply of timber could be maintained. The heavy rainfall and moderate climate of the coast region induces a very rapid reforesting of the cut-over tracts, which very soon become dense thickets of vigorous young trees.

Two days were spent very pleasantly in Tacoma, which is most attractively placed on the high shore of Puget Sound, with a magnificent view of the Cascade Mountains, and Mt. Rainier, the grandest of all the great snow peaks south of Alaska — indeed, to me it is the finest mountain I have ever seen. The rugged cone, recalling in form that of the Jungfrau, is even more imposing than Shasta, and being seen from the level of the sea, it loses nothing of its 14,000 feet of height.

The luxuriant growth of all kinds of vegetation about Tacoma testifies to the heavy rainfall of this region, and during my stay, both going to and returning from Alaska, rain fell much of the time. In spite of the rain, however, several trips were made in the neighborhood, which is very attractive.

The character of the country about Tacoma varies remarkably within a short distance. To the south are open regions, recalling the oak openings of northern Illinois or southwestern Michigan. The dry ground is covered with a thin growth of grasses or low thickets of ferns, brambles, and other low shrubs, with here and there clumps of scrub oaks — probably *Quercus lobata* — and a few stunted firs. The showiest flower of this region was a handsome small turk's-cap lily, with orange-red, spotted flowers. The common bearberry, *Arctostaphylos uva-ursi*, was common, the spreading mats of glossy green foliage being extremely ornamental.

The site of the town itself was formerly covered by a dense fir forest, remains of which may still be seen in the outskirts. When I arrived, in mid-June, the gardens were beautiful with the early summer flowers. Superb roses grew in the most luxuriant profusion, and were in their prime. I was told that a few weeks earlier the rhododendrons had been equally fine.

The most attractive place in the neighborhood is Point Defiance Park, a government reservation which is open as a public park. It is a magnificent tract of forest, on the shore of the Sound, which has been preserved, and is of course especially interesting to the botanist, as it gives an excellent idea of the character of the forest which formerly covered the whole of the surrounding country. The trees are for the most part the prevailing Douglas fir, and while these do not grow so thickly as in the best lumber regions, still the individual trees are magnificent specimens. Some of them must be 250 feet high, with immensely tall trunks eight feet or more in diameter near the ground. These straight columns run up to a prodigious height without branches, and one only realized the great size of the trunks on coming close to them, as their enormous height gives them a deceptively slender appearance. I was told that these trees were not to be compared to some of those further inland, but they were the finest specimens of the species that I have ever seen.

A few cedars and hemlocks were mixed with the firs, but neither were of remarkable size, although at Vancouver I remember seeing cedars of gigantic size. The undergrowth of the forest was much like that in northern California. The commonest of the deciduous trees noted were *Acer macrophyllum*, *Cornus nuttallii*, and *Alnus oregana*. The excessive moisture causes an extraordinarily rank growth of ferns and undershrubs, almost tropical in its luxuriance. *Pteris aquilina* grew everywhere, some of the fronds being ten feet or more in height, and *Rubus nutkanus*, growing with them, was almost as high. In the low grounds *Equisetum maximum*, five or six feet high, was conspicuous. A few specimens of Linnæa were seen, and another characteristic plant was *Gaultheria shallon*, in full flower. It forms a prostrate bush a foot or two in height, a veritable giant compared to the eastern wintergreen.

At Tacoma I had the good fortune to meet Mr. Walter Evans, of the Department of Agriculture, who was also bound for Alaska. I am much indebted to him for information concerning the flora of the Northern Pacific Coast, with which his former trips had made him familiar.

The voyage to Alaska from Puget Sound is a most attractive one, and during the brief summer season is yearly drawing a larger number of tourists. Last summer, however, the majority of the north-bound passengers were drawn by other attractions than the charms of the scenery, and our passenger list was made up largely of persons bound for Skaguay and Dyea, *en route* for the Klondike.

The route follows the channels between the numberless islands off the coast of British Columbia and Alaska, and at no time do the steamers enter the open sea. Often the channel is so narrow that one could almost throw a stone ashore, and it is hard to realize that one is not sailing through a lake, or even a river, as there is no trace of the ocean swell nor heavy waves, except at one or two points where, for a short distance, there is a break in the barrier of islands protecting the inland channel.

Everywhere the shores are heavily wooded to the water's edge — indeed, the whole coast from Puget Sound to Sitka is covered with an almost unbroken forest, where the trees stand so close together that the dead trees are held upright by their living companions. These bleached skeletons, seen everywhere in the forest, give to it a very peculiar aspect.

Above the timber line the rugged tops of the mountains project, with here and there masses of snow, which become larger and more numerous as we go northward, and come down until they meet the forest. From the steep mountain sides little streams rush down in a series of cascades, which finally fall into the sea.

As we proceed northward the scenery grows more and more striking. The mountains become higher and more rugged, and the summits are completely covered with perpetual snow and ice, and the snow-line descends farther and farther, until finally we reach a land of glaciers, many of which come down to the sea. The wonderful panorama of snow-clad, glacier-sculptured mountains reaches its climax on the last day of the voyage, passing through Lynn channel after leaving Skaguay, the most northerly point visited. Here the mountains rise abruptly from the water to a height of 8000 feet and more,

and from them the great glaciers flow down, sometimes reaching the sea, where the great fragments broken off float off as icebergs. None of the ice masses seen were of very large size, but their fantastic shapes, and the exquisite hues of the pure ice, presented a beautiful spectacle. At this high latitude, at the end of June, the sun did not set until nearly ten o'clock, and it did not become really dark at all, so that we had to go to bed by daylight — a novel experience for most of us.

Stops were made at Wrangell, where there were standing a number of the curious totem poles, which unfortunately have since been burned. Stops were also made at Juneau and Skaguay, the latter a most unattractive collection of shabby huts, raised on piles to keep them out of the water. Near by was the rival town of Dyea, which we did not visit.

The vegetation is everywhere luxuriant, showing the heavy rainfall and relatively mild climate of the coast. The variety of plants, however, is not very great, and as our stops were not of long duration, the opportunities for botanizing were somewhat limited, and no plants were seen which were not also found later at Sitka.

Sitka offers many attractions to the tourist, being most beautifully placed on Baranoff Island, one of the largest of the innumerable islands making up the Alaskan archipelago. Evidences of the Russian occupation are seen on all sides, nearly all the buildings in the little town dating back to the period when this was Russian territory. The massive buildings of hewn logs, with steep moss-covered roofs, and the Greek church lifting its turnip-shaped green cupolas above the other buildings at the head of the main street, give the town a very foreign air, which is not lessened when we find how many of the Russians still remain. The bulk of the population is still made up of the Russians and the native Indians, whose quarter, facing the harbor, presents a picturesque medley of big dug-out canoes, and frames for drying fish, among which are snarling and fighting a rabble of wolfish dogs, which seem to be a necessary adjunct of every self-respecting family of Alaskan Indians.

The harbor is surrounded by mountains on which the snow lies for most of the year, and there are numerous wooded islands

scattered over it which add much to its beauty. The country about Sitka shows a good deal of variety of surface and elevation, and the flora for so northerly a region is decidedly rich. A good road following the harbor for some distance, and several trails, make it easy to get about in the neighborhood of the town itself. The favorite walk is along the beautiful Indian river, which is crossed by a suspension bridge, and along which are most attractive paths through the forest.

The predominant tree of the Alaska forest is the tide-land spruce (*Picea sitchensis*), which forms extensive forests everywhere along the coast south of Sitka. About Sitka the tree reaches a large size, some trunks measured being upwards of twenty-five feet in circumference at about five feet above the ground, and these trees were at least 150 feet high. Like the California redwood, the tree is very tenacious of life and sprouts freely from the stump, as well as springing up quickly from seed, so that when this forest is cut over there soon grows up a dense thicket of young trees. Many trees have the base of the trunk much swollen, and sometimes with a space between the roots, so that the tree is raised, as it were, on stilt-like props. The origin of these peculiar structures is found in the frequent sprouting of the seeds on old stumps or prostrate trunks. These resist decay for many years, and trees of very considerable size are often met with, perched astride of the old fallen trunks, and sending down large roots which finally reach the earth. When the old trunk at last decays, the young tree is left supported by a hollow arch of roots, which often never becomes entirely filled up by subsequent growth.

In the more remote regions two species of cedar (*Thuja plicata* and *Chamæcyparis nutkænsis*) are found, but about Sitka most of the cedar has been cut, as it is in great demand for making the big dug-out canoes, as well as for other purposes. The northern hemlock (*Tsuga mertensiana*) is common about Sitka, and reaches a large size, although hardly equal in size to the spruce. It closely resembles the eastern hemlock, especially when young.

Owing to the excessive moisture, the ground in the forest, as well as every stump and fallen tree, is covered with a thick

carpet of beautiful mosses and liverworts, comprising numerous species. Various species of Hypnum are the commonest, but Polytrichum, Mnium, and others of the larger mosses were conspicuous. Of the Hepatics, the cosmopolitan *Pellia epiphylla* and *Conocephalus conicus* were the most abundant, but there were a number of others which were common. Lichens also were abundant and conspicuous.

The mossy carpet was brightened with many charming flowers, mostly common northern genera. Linnæa, *Smilacina bifolia*, *Cornus canadensis*, Moneses, and various Saxifragaceæ were abundant, and in addition to these were beautiful ferns and the glossy fern-like leaves of Coptis sp.? Most of these woodland flowers showed the white or pale pink color of so many of our vernal flowers, but there were a few of more vivid colors. The bright red and yellow columbine (*Aquilegia formosa*) was common, and a very handsome violet-purple iris, probably *I. sibirica*, was seen in some of the gardens, but was not met with growing wild, although it is said to be common in some parts of Alaska.

Along the edges of the forest and in the clearings were thickets of the salmon-berry, *Rubus speciosus*, whose crimson flowers and big showy orange and scarlet berries make it the handsomest of its tribe. The fruit is not unpalatable, but is far inferior in flavor to the ordinary red raspberry or the blackberry. They are highly prized by the natives, who preserve large quantities for winter use. Several other species of Rubus are common, as well as various Vacciniums and species of wild currants, all of which are important articles of food among the Indians.

Certain plants were noticed on some of the islands which were not seen about the town. Of these the most noteworthy were *Campanula rotundifolia*, which was very fine on one of the islands, popularly called "blue bell island"; *Rubus nutkanus* and *Fritillaria kamtschatcense* were also collected, the latter, however, past flower.

The low ground in the neighborhood of Sitka is largely covered with a growth of Sphagnum, and, as usual with peat bogs, harbors many interesting plants. In a small lake back of the

town were a number of aquatics, the most conspicuous of which was *Nuphar polysepalum*, with enormous yellow flowers and big leaves. In the Sphagnum grew Linnæa, cranberries, *Vaccinium vitis-idæa*, crowberry, *Drosera rotundifolia*, Menyanthes, and the closely related *Nephrophyllidium crista-galli*, cotton grass, *Kalmia glauca*, and other characteristic bog plants.

On the higher portions of the bog were small groves of *Pinus contorta*, the only pine seen in Alaska, and some small cedars (probably Chamæcyparis), which, not being in fruit, could not be positively identified.

The most conspicuous bog plant of this region is the western skunk-cabbage (*Lysichiton kamtschatcense*), which abounds everywhere along the Northern Pacific Coast, and is the only Aroid of this region. The enormous leaves, sometimes three feet in length and a foot wide, resemble some tropical plant, and recalled to me some of the great West Indian species of Anthurium. Indeed, both the leaves and the inflorescence, with its large, lemon-yellow spathe, recall Anthurium rather than Symplocarpus, with which it is ordinarily associated. The popular name is rather a libel on this very handsome Aroid, as the odor is not at all noticeable.

There are certain drawbacks in exploring the forest, which is so dense that it is not safe to leave the trails. A few feet away from the trail there is an almost impenetrable jungle, the ground covered with fallen logs and a tangle of dense undergrowth which makes one's progress toilsome in the extreme, and once out of sight of the trail the danger of losing one's self completely is very great. The appropriately named "devil's club" (*Echinopanax horridus*), a comely enough plant to look at, with its big, bright green maple-shaped leaves, but whose stem is covered with bunches of needle-like spines, abounds everywhere, and is the veritable terror of these northern woods.

In the more open ground, grasses of various kinds flourish, among them timothy, orchard grass, blue-grass, as well as red and white clover, which are completely naturalized, and would doubtless furnish good feed for horses and cattle, although the

excessive dampness of the climate must render the curing of hay a serious problem.

As might be expected, the mild, moist climate is favorable to the growth of most of the lower plants. Ferns are abundant and in considerable variety, considering the high latitude. No exact list was made, but there are probably a dozen species about Sitka. *Pteris aquilina* is not so common as it is farther south, but several species of Asplenium and Aspidium were very abundant, and *Asplenium filix fœmima* was especially luxuriant, with fronds five or six feet high. On the rocks near the shore a Polypodium (*P. falcatum?*) was common, and in the woods, besides the ferns already mentioned, the common beech fern (Phegopteris) and the striking *Blechnum spicant* were abundant. Alaska is the only region in America, so far as I know, where the latter common European fern is found. The only other Pteridophytes noted were *Equisetium arvense* and *Lycopodium annotinum*, which was not, however, abundant.

Fungi abounded, but no special notes were made in regard to them. The most conspicuous parasitic one was an Exobasidium, probably *E. vaccinii*, which was very common on Menziesia, where it formed remarkable distortions both of the twigs and leaves, as well as the flowers. These gall-like growths, whether of the leaves or flowers, are usually quite destitute of chlorophyll, and of a pale pink color, with a delicate frosty bloom, caused by the spores of the fungus. The whole region promised a rich harvest to the mycologist.

Very little was done in the way of collecting fresh-water algæ, but material gathered in the bog pools showed many beautiful desmids and other interesting forms. The marine flora is exceptionally rich in the larger brown seaweeds, the Laminariaceæ being specially conspicuous and represented by many genera and species. The large kelps, like Nereocystis and Macrocystis, grow much higher up than they do farther south, and are correspondingly shorter. The tides are very marked at Sitka, and it was striking to see how near the high-tide mark many of the brown algæ grew. Fucus, especially, grew where it was covered by the tide for a very little while, remaining exposed for much the greater part of the time. The

moderate temperature of the air and the prevalence of cloudy skies no doubt favor this habit. These northern waters are especially rich in the gigantic kelps, so characteristic of the Pacific, and the masses of these big brown seaweeds attract the attention of the most careless observer.

After two weeks spent most pleasantly at Sitka, the steamer was taken for the return voyage. On the way back we put into Glacier Bay, where a morning was spent scrambling over the moraine of the great Muir glacier, which fills up the head of the bay, and whose sheer cliffs of glittering ice extend for more than a mile across it, and rise two or three hundred feet above its waters, gray with the detritus of the glacier, from which great blocks of ice are constantly falling to add to the fleet of icebergs sailing out from the bay into the ocean. For many miles back of the ice cliffs the rough surface of the glacier extended to the bases of the snow-capped peaks, which formed the impressive background of this magnificent picture. The face of the glacier presented a marvelous variety of color. In places the cliffs of ice were pure white, with faint blue veins looking like marble, while at other points crags of crystalline clearness glittered in the sunlight with all the tints of the rainbow. The crevasses were of the purest blue, ranging from faint turquoise tints to the deepest sapphire and indigo. Now and again a fragment would break off and fall with a thunderous crash into the bay, where its weight would carry it far below the surface, whence it presently emerged with a great splash like some huge monster, and presently started oceanward to join the rest of the iceberg fleet. Most of these floating ice masses were very free from dirty surface ice, and looked like huge blocks of blue-veined marble, or sometimes were solid masses of pure blue ice of the most exquisite shades.

The huge moraine flanking this glacier presented a most forbidding appearance, and very little vegetation has succeeded in gaining a foothold. Besides a dwarf prostrate willow, a few inches high, which was seen in several places, the only other plant noticed was an Epilobium, the finest of the genus that I have seen. The deep crimson flowers, twice the size of those of the common willow-herb, were magnificent and especially

striking, growing as they did by themselves in the stony wilderness of the moraine.

The return voyage is rather an anti-climax, as the scenery grows less impressive as we go southward. The last day of the voyage, however, afforded us one more impression to carry away. Going north, we had missed the fine view of Mt. Baker, off Victoria. This is the most northerly of the group of snow peaks to be seen from Puget Sound. As we approached Victoria late in the afternoon, we saw far away to the southeast the perfectly symmetrical cone, standing quite alone and reflecting the afternoon sunshine from its smooth slopes, and rising apparently directly from the sea. Two years before I had seen this mountain under similar conditions as we sailed out of Victoria, bound for Japan; and one who has seen the peak of Fuji Yama, on the other side of the Pacific, must be struck with the resemblance between the two mountains. As the light faded on the slopes of Baker we sailed into Victoria and our voyage was over.

As might be expected from its position, the flora of maritime Alaska combines characters both American and Asiatic. While many of the plants were the common sub-arctic types, some like *Pinus contorta* and *Tsuga mertensiana* are distinctly American; while, on the other hand, *Picea litchensis* is found on the northern Pacific coasts of both Asia and America, and a number of the herbaceous plants, *e.g.*, Lysichiton, Fritillaria, *Trientalis europœa*, *Blechnum spicant*, are probably all immigrants from Asia. The continuous chain of the Aleutian Islands connecting the two continents makes the presence of these Oriental immigrants readily understood.

IS THE WHITE RIVER TERTIARY AN ÆOLIAN FORMATION?

W. D. MATTHEW.

When the Cenozoic of the Great Plains of western North America was explored in the fifties and sixties, the theory was formulated that it was deposited as sediment in a succession of vast fresh-water lakes. This view was generally held until the recent explorations, especially under auspices of the United States Geological Survey, which have caused it to be considerably modified. The Loup Fork has been shown to be largely a flood-plain deposit, the Pleistocene chiefly æolian; and Mr. Darton has lately traced an extensive system of river deposits overlying the White River clays. The main body of the White River formation, consisting of fine-grained calcareous "clay," or chalk, with intercalated beds and lenses of sandstone, usually of limited extent and in subordinate amount, has, I believe, been universally considered lacustrine.

There are some very serious difficulties, stratigraphic and paleontologic, in the way of this theory, and observations in Kansas, Nebraska, and Colorado, during the last two summers, suggested to the writer another view, which appears to do away with these difficulties.

Objections to the Lacustrine Hypothesis.

I. *Stratigraphic.*—(*a*) We must assume the former existence of a vast lake covering a large part of Nebraska, Colorado, Wyoming, South Dakota, and perhaps extending even farther northward, with an area dwarfing into insignificance any existing lake. We must assume an eastern and southern barrier high enough and extensive enough to hold in these waters during the entire Oligocene period, which yet entirely escaped

erosion, and subsequently disappeared, leaving no trace, direct or indirect, of its former existence.

(*b*) So large a lake should surely have left strongly marked wave-cut terraces on its shores and islands. I have never seen or heard of any such (as distinguished from wind-cut terraces), although the short-lived glacial lakes gave rise to abundant evidence of this sort.

(*c*) There is a general absence of minute stratification in the clays. They contain heavy beds or layers of different color or hardness, but no fine stratification or horizontal cleavage. The Niobrara Cretaceous, composed of equally fine material, not very different in composition, shows a marked contrast in this respect, fine stratification being universal.

II. *Faunal.* — These difficulties are yet more serious.

(*a*) There are no plants — tree trunks, stems, or leaves — in the clays, although these deposits are well fitted to preserve them. The plant remains that I have seen are limited to the coarser (fluviatile) beds above. Plant remains have been described from the "Bad Lands of Dakota,"[1] but I do not know their exact occurrence.

(*b*) There are no aquatic invertebrates.

(*c*) There are no fish.

(*d*) There are no aquatic reptiles; but land tortoises[2] are the most abundant fossils found, and lizards and snakes occur in considerable variety. The only exceptions to this statement, as far as I know, are a crocodile skull and two specimens of Trionyx, found in South Dakota; but whether in the clays or not, I am uninformed.[3]

(*e*) Mammals occur in great numbers and variety, scattered all through the clays. Of over fifty genera only three are probably aquatic; most of them are land mammals, some are of uncertain habitat. The three aquatic forms are a rhinoceros, Metamynodon, confined to a single layer of *sandstone* in the Oreodon beds, and an oreodont, Leptauchenia, and a beaver,

[1] Lesquereux. *Cretaceous and Tertiary Flora.*

[2] Family Chersidæ, genera Testudo, Stylemys (? = Testudo), — Zittel, *Handbuch von Paläontologie.*

[3] One of the specimens of Trionyx is certainly from the sandstones.

Steneofiber, confined to the probably fluviatile beds at the top of the White River.

The fauna of the clays is, then, exclusively a land fauna. The lacustrine theory requires us to suppose that the animals were swept down by rivers into the lake. Modern rivers do sometimes bring down carcasses of land animals in their floods, along with an overwhelmingly greater amount of tree trunks, leaves, etc., and mingle these with their delta deposits, forming estuarine or delta beds, a well-marked facies of sediments. But the White River clays are not delta deposits; they must, if lacustrine, have been deposited far out in the open lake. How did the land animals get out into this open lake? The current could not take them out, for it was insufficient even to arrange the fine particles of sediment. They might conceivably have floated out. But why in such numbers and so uniformly distributed? How did separate limbs, gnawed, bitten, or weathered bones get there? How did the tortoises get out into the lake? Why were no tree trunks or plant remains floated out, if the animal carcasses could float out? Why are there no fish or invertebrate remains? Contrast this fauna with the Cretaceous, where marine reptiles, fish, and invertebrates are exceedingly numerous, amphibious and land animals extremely rare, and plant remains by no means common. Contrast it with known lacustrine deposits, as some of the small Pleistocene lakes of the east, where fresh-water invertebrates are very abundant, fresh-water fish common, and land plants or water plants, or both, often make up a large part of the deposits, while land animals are rare, except in peat bogs.

If, then, the White River clays are lacustrine, they must have been deposited in an absolutely lifeless sea, surrounded by a well-watered region devoid of vegetation, yet sustaining an animal population of incredible density. And even this combination of improbabilities cannot account for some facts, and does not satisfactorily account for others.

Modern Deposits of the Plains.

There are two kinds of deposition now going on in this region:

I. *River and Flood Plain Sediments.* — Sands and clays are deposited in the valleys whenever continental deformation causes a decrease in the fall of the river bed. Mr. Gilbert's clear exposition of this mode of sedimentation, as exemplified in the Arkansas valley, makes further comment superfluous.[1]

II. *Prairie Loess.* — Wind erosion (deflation), very active in this arid region, carries off from all exposed rock or soil a large amount of material, most of which is deposited on the sodded, or partially sodded, prairie surface. The deposit is heavier in hollows, where temporary "lagoons" or denser grass occur, and tends to produce an extremely level and uniform surface. This deposition through the Pleistocene has produced a fine unstratified, extremely uniform covering of loam (loess or marl) over the greater part of the plains; I have seen it in places two hundred feet thick. It was formerly supposed to be a lacustrine sediment, and that the rivers subsequently cut their channels in the floor of the dried-up lake. It is now, I believe, generally considered æolian, and a significant corollary of the mode of deposition, outlined above, is that it was built up at the sides of the river valleys, deposition in the valleys being checked by erosion; the valleys, therefore, are older than the plains.

Practically the only fossils found in the loess are the bones of land animals. No plant remains occur; the prolonged exposure to water and air permits the nearly complete oxidation of vegetable matter. Near the surface are peaty layers and land shells, but the conditions of burial do not favor their fossilization. Dark lines mark the position of lagoons on the former prairie surface, and slight changes in the quality or fineness of the deposit produce a bedded appearance, uniform over large areas. The extent and uniformity of this Prairie Loess are especially notable. It is the prevalent surface deposit over half a dozen western states in the greater part of the plains region.

[1] *U.S. Geol. Survey, XVIIth Ann. Rep.*, Pt. ii, p. 575.

The occurrence of mammal bones on the surface may be taken as indicating the way they occur within the loess. Skeletons are more or less complete according to the extent of disturbance by carrion feeders. Skulls, limbs, or individual bones are commonly found separated — carried off by other animals. Limbs are very apt to be bitten off across the upper limb bone, leaving the head of the humerus or femur in its socket. Bones are often more or less gnawed or bitten, sometimes weathered, but never water-worn. In and around "salt licks," or lagoons, a mingled heap of bones of many animals is often found, individuals usually hopelessly mixed.

The upper part of the Prairie Loess contains bones of Bison and other modern prairie inhabitants in various early stages of fossilization. The lower part contains Equus bones.

The Æolian Hypothesis.

I believe that the White River clays, in Colorado at least, are chiefly æolian deposits, similar in origin to the Prairie Loess. Most of the sandstones are probably fluviatile, especially those occurring in lenticular masses. The sandstones with the *stratified* clays parallel the modern fluviatile deposits of the valleys. Some sandstones may be æolian.

1. The fauna is what we should expect to find in an open, grassy region. The animals are all land forms, and the most abundant genera, Oreodon, Mesohippus, and Hyracodon, have distinctively *cropping* teeth. The abundant and varied fauna has been supposed to indicate a warm, moist climate; it is paralleled, however, by that of the dry region of South Africa, and the modern fauna of the plains is by no means small. The occurrence of land tortoises cannot be explained by the lake theory, and its explanation of the other land fauna appears an exceedingly improbable one, involving several practical impossibilities, as noted above.

2. The occurrence of specimens is precisely, in every detail, the same as above stated in the modern prairie deposits, and their abundance in Colorado is about the same. Gnawed bones,

bitten off limbs, mixed accumulations in fine uniform sediments, are inexplicable on the lake hypothesis.

3. The character of the clays is exactly what the loess would probably assume on consolidation, and does not agree with the Niobrara chalk, a deposit similar in origin to that proposed by the lacustrine theory for the White River clays, except that the water was salt instead of fresh.

4. The great extent and uniformity of the White River and the details of its distribution appear to the writer to agree with that of the loess, but to be difficult to explain on the theory of lake deposition.

This view of the origin of the White River beds involves a great change in our notions of the climate and conditions of the west in the later Tertiary. If it be correct, these must have been much like those now prevailing in the same region; and our ideas as to the probable appearance and habits of these extinct animals can be made much more definite and certain.

This theory has probably little or no application to the Eocene beds west of the Rockies. These do not contain the fine unstratified chalks; they are in well-defined basins enclosed by mountain ranges and drained by great canyons; land tortoises are as rare in them as water tortoises in the White River; alligators, etc., occur frequently, and the characteristic plains types of mammals of the White River are small, scarce, or undeveloped. Furthermore, before the Sierras and Coast Range were elevated, the rain now falling on the Pacific Coast must have fallen where the Great Basin now is; while we have no *known* adequate cause for so great a change in the climate of the plains between the Oligocene and the present time. The Eocene deposits are probably a mixture of lake and fluviatile sediment—what proportion of each would not be easy to determine.

OVUM IN OVO.

FRANCIS H. HERRICK.

I.

An interesting case of egg within egg recently came to hand, which was unique in this respect : that the smaller enclosed egg lay in the yolk and not in the albumen of the surrounding egg, as in all similar instances hitherto recorded.[1] This hen's egg had unfortunately been cooked. When it was opened, and the white broken into, a suspicious-looking fleck was seen on the surface of the hardened yolk, the removal of which disclosed the imbedded egg. The parts of the containing egg have not been preserved, so that I can record only the general facts here given.

The included egg measures 17 × 21 mm., is of symmetrical ovoidal form, possesses a hard shell, shell membrane, and small yolk. The shell has a coarse granular texture, and a coffee

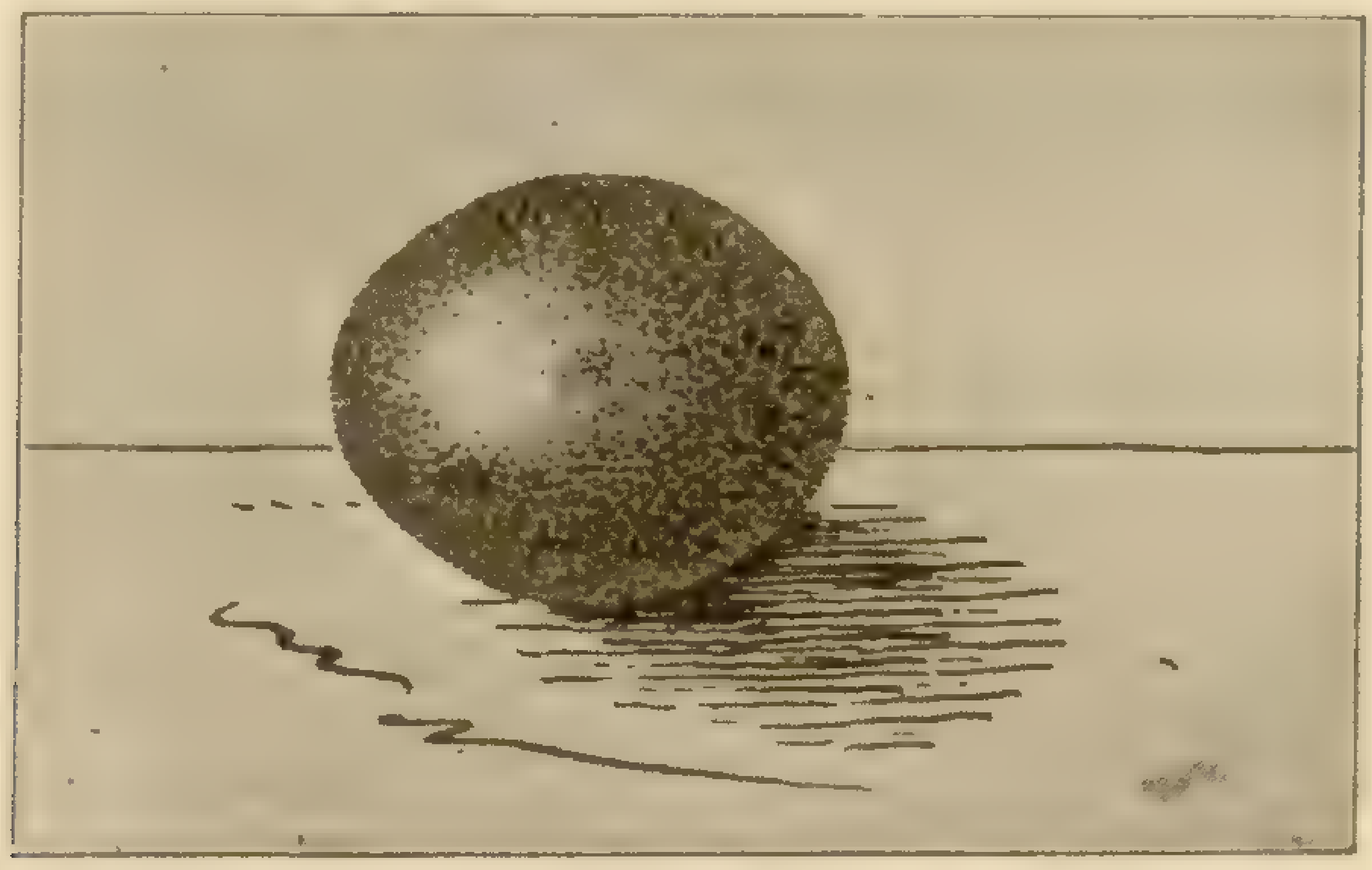

Fig. 1. — Small egg removed from yolk of larger egg. Natural size.

color, sprayed with brown pigment. Its form and appearance are represented in Fig. 1, its relation to the containing egg in Fig. 2.

Since writing the foregoing and following parts of this paper,

[1] I am indebted for this specimen to Mr. Herbert Tetlow and to Mr. E. B. Duffy, by whom it was obtained.

I received a second example of *ovum in ovo*, which is represented in Fig. 3.[1] The smaller enclosed egg lies in the albumen of the larger, as in the cases hitherto described. It measures about 18 × 22 mm., has a clear shell of even texture,

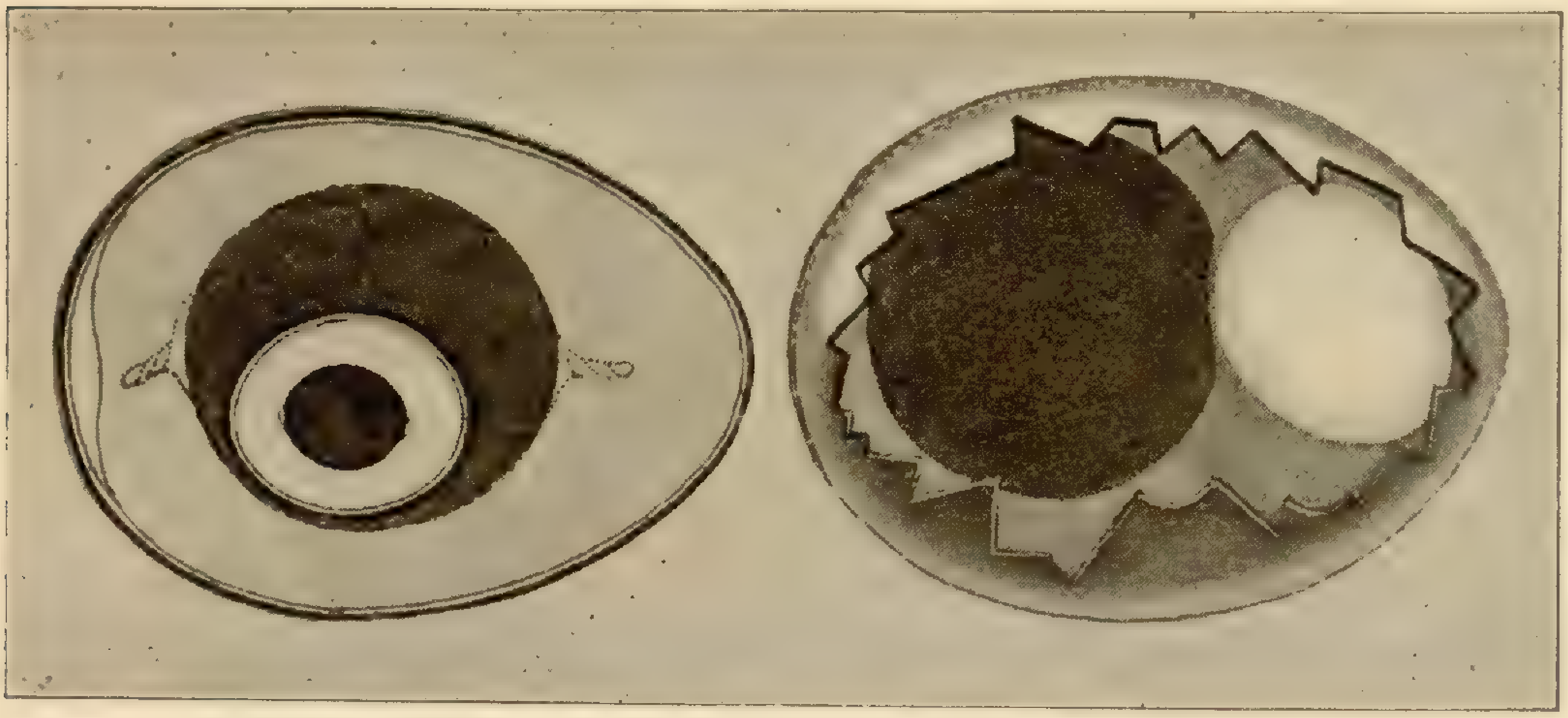

FIG. 2. FIG. 3.

FIG. 2. — Diagram to show the relations of *ovum in ovo*, in which the enclosed egg (Fig. 1) lay in the yolk. This represents the relative form and size of the included egg, and shows its general relation to the yolk of the enclosing egg. In other respects the figure is conventional. Shell, shell membrane, albumen, and yolk are represented in each egg. About four-fifths natural size.

FIG. 3. — Diagram to show the relations of *ovum in ovo*, in which the included egg lay in the albumen. The shell is represented as broken, exposing the yolk shaded dark, and to the right the small enclosed egg, which is white. About four-fifths natural size.

shell membrane, and albumen. Apparently no yolk is present; at least none could be found in the specimen, which has been somewhat mutilated. The parts of the surrounding egg appeared normal in every respect.

II.

These cases belong to that class of abnormalities in the eggs of birds which originate before incubation, and to the variety called *ovum in ovo*. In all recorded cases of this type the contained bodies lie in the albumen, or at least not in the yolk of the surrounding egg.

In 1878 Parona and Grassi[2] described and figured a good

[1] I am enabled to examine this specimen through the kindness of Professor T. H. Morgan.

[2] Sovra alcune monstruosità di uova di gallina, *Atti della Soc. Ital. di Sci. Nat.*, Milano, vol. xx (1878), tav. 2a.

example of the more common condition in which the included egg, an elongated ovoidal body, lay in the albumen. The yolk of the larger egg possessed a normal blastoderm. These writers gave a history of monstrosities of this class known up to that time, from which the following abstracts are drawn.

Davaine, in a work published in 1860, gave a résumé of cases of *ovum in ovo* then known. He found that the enclosing egg might be larger or smaller than normal, having shell, albumen, and yolk, the latter liable to deformity from disturbance of the foreign body. The included egg was very rarely of normal size; usually it was small and devoid of yolk. Clayer, in 1682, described a case where the included egg was very small, but possessed a yolk.

A similar example was also reported by Yung in 1671. The yolk of the inside egg was very small, and possessed two chalazæ. Rayer described, in 1849, a goose egg of colossal size, which contained an egg of normal dimensions, having yolk, albumen, and shell. The outer egg was also complete, although its yolk was flattened by pressure. A few years later three similar cases were reported by De Moroga, Aucapitaine, and Alessandrini. The latter reported the case of an egg of normal size, which contained a small egg complete in all but the shell.

In 1856 a case is cited, by Davaine, of three eggs enclosed by a common shell, and still later a precisely similar phenomenon was described by Flourens.

Panum,[1] who studied for several years the abnormalities of birds' eggs and collected many examples, met with the *ovum in ovo* only once. This resembled Rayer's goose egg, and came from the Indian jungle fowl. The inside body corresponded to the normal egg in size, while the surrounding egg was of relatively huge proportions. Panum adds that in 1858 a remarkable egg of a Cochin China hen was described. It was very heavy and contained two yolks and one ordinary egg with solid shell. Still another egg, analogous to that of Rayer's goose, was described by Bert in 1861. Patrona and Grassi

[1] *Untersuchungen u. d. Entstehung d. Missbildungen.* Berlin, 1860 (cited by Patrona and Grassi).

remark that the foregoing are the only cases recorded of this singular abnormal production, but that it would be possible to cite more than thirty instances in which small yolkless eggs have been found enclosed in another egg apparently normal. Later additions to this literature have been made by Landois in 1882,[1] and by Schumacher in 1896.[2]

Landois remarks that in most cases of *ovum in ovo* the included egg is small and yolkless, and sometimes possesses a very abnormal form. In one erratic individual it resembled a tapeworm, consisting of a button the size of a pin head, followed by a fibrous section, and ending in a broad flattened string. He thinks that most so-called tapeworms in hens' eggs are nothing more than monstrosities of this kind.

In the case described by Schumacher the enclosing egg was apparently normal, and, like that figured by Patrona and Grassi, possessed an egg-like inclusion in the albumen. This was of regular oval form, a little larger than that here described, and, besides hard shell, possessed a stratified albumen, an irregular spirally twisted yolk mass, measuring 8×4 mm., with small chalazæ at either end. There was no blastoderm.

III.

Reviewing the cases of *ovum in ovo* in zoölogical literature, we may classify them in the following manner:

I. Enveloping egg usually normal, but occasionally of large size; blastoderm recorded in at least one instance.

Enveloped egg:

(*a*) In yolk; small; composed of shell, shell membrane, albumen, and yolk; no blastoderm known to occur in this or in the following variations; single case recorded in this paper (Fig. 2).

(*b*) In albumen; small; composed usually of shell, shell membrane, albumen, and rarely with yolk; few cases reported.

(*c*) In albumen; small; usually with shell, shell membrane, and albumen, but no yolk; most cases of *ovum in ovo* reported are of this kind (Fig. 3).

(*d*) In albumen; usually small and variously distorted, so as to bear little resemblance to an egg at all.

[1] *Fremde Einschlüsse in Hühnereiern.* Humboldt, Heft 1 (1882), pp. 22–24.

[2] Ein Ei im Ei, *Zoologischer Anzeiger*, Bd. xix (1896), pp. 366–368.

II. Enveloping egg of colossal size; complete; blastoderm probably present.

Enveloped egg:

(*a*) Without shell, but otherwise complete. In this case a common shell may surround two or three eggs complete except for shells and shell membranes; forming "double-yolk" or "triple-yolk" eggs.

(*b*) One of the enclosed eggs of normal appearance and size, possessing shell, albumen, and yolk; the other eggs surrounded by a common shell, but having no shells of their own.

According to the accepted accounts, the yolk of the fowl's ovum is of normal size when it leaves its vascular capsule in the ovary, and is taken up by the infundibulum. Reaching the oviduct it receives its first layer of albumen, and is carried slowly down the tube by peristaltic muscular contraction of the walls. Near the lower end of the oviduct the final layers of albumen are added, and in the distal extremity of the duct, called the uterus, the shell is formed.

In the opinion of several writers the small included egg represents a fragment of a normal ovum which has been ruptured, and thus has parted with some of its substance after leaving the ovary. This fragment is then treated in the oviduct like a full-sized egg. The small egg-like body thus produced is sometimes laid, but occasionally it is driven by anti-peristaltic action up the tube until it collides and fuses with the mother egg. This theory will suffice to explain the first class of inclusions on the supposition that rupture takes place in the upper part of the oviduct, or at least after the first layers of albumen have been added to the normal egg. Since the small included eggs are generally yolkless, we must infer that such ruptures are, as a rule, confined to the albumen. It seems more probable that the small egg becomes enclosed before the shell membrane is formed over a normal egg, with little if any retrogressive movement. Furthermore, it is possible that any substance which serves as a local stimulus to the upper part of the oviduct, whether coming from the ovary as abortive egg or egg-fragment, or from the duct as secreted product, may serve as a nucleus, about which an egg-like body may be formed. Normally laid eggs, indeed, tend to sweep the oviducal canal

clear of all obstructions, whether they be abortive eggs, blood clots, feathers which rarely grow from its walls, or parasites which find their way into it. These bodies are taken up by the egg, and become imbedded in it. In one of the cases recorded in this paper the obstruction or small "egg" (Fig. 2) has been pressed through the albumen, through the vitelline membrane, and thus into the yolk itself. It is evident that inclusions of the first type are not true eggs in any strict sense, since, so far as known, they contain no protoplasm.

The theory of yolk-hernia will not explain the second class of abnormalities, such as double or triple yolk eggs. We have here a case of fusion of the albumen in two or more ova, which are treated in the uterus as one egg and surrounded by a single shell. This process is sometimes complicated by the inclusion of a third egg of normal size and already covered by a hard shell. These conditions may be brought about by irregularities in the mechanism of the oviduct, as when any given egg does not receive its shell and is not laid before it encounters others coming down the oviduct at the same time.

According to Duval, an egg usually spends thirty hours in the oviduct, twenty-four of which are passed in the uterus, and if the fowl lays once in forty-four hours a single egg will be found in the oviduct at any given time. When the intervals of laying become shorter, however, an egg may be found at either end of the tube. In some of the cases described three ova must have been in the tube and collided there, owing to disturbances in the normal rhythms.

ON THE HABITS AND STRUCTURE OF THE COCCID GENUS MARGARODES.

T. D. A. COCKERELL.

THERE has recently been made a new pathway across the campus of the New Mexico Agricultural College at Mesilla Park, and the earth on it is still soft and loose. Walking this morning (January 16) up this path, I saw, just opposite the door of the new Science Hall, a couple of small winged insects, hurrying to and fro as if they had lost something, almost beneath my feet. Curious to know what was stirring at this time of year, I knelt down, and was surprised to find that they were male coccids. Presently, greatly to my astonishment, one of them began to dig into the earth, and in a moment completely buried itself, leaving only the tips of its long abdominal filaments visible. I dug it out and discovered the object of its search, which was a plump yellow female coccid.

These coccids, ♂ and ♀, prove to belong to the singular genus Margarodes, never before found in New Mexico. This genus was established by the Rev. L. Guilding, in 1829, for a species of the West Indies; others have lately been described by Giard from Chili and the Cape of Good Hope. One form, *Margarodes formicarum* Guilding, var. *rileyi*, Giard, has been found on some of the Florida Keys. An allied genus, Porphyrophora, with several species, occurs in Europe; it was named by Brandt in 1835.

These two genera (if they are to be separated) form the subfamily Porphyrophorinæ or Margarodinæ, closely allied to the Monophlebinæ, and especially to the Xylococcinæ of Pergande. Both Margarodinæ and Xylococcinæ are very well separated from Monophlebinæ by the absence of legs and antennæ in the intermediate stages of the female, and the total absence of mouth parts in the adult female. From one another they do

not differ so much, and I am inclined to treat them only as tribes of one subfamily, thus:

Tribe, Margarodini. Subterranean; anterior legs of both sexes (adults) adapted for digging. Tribe, Xylococcini. Arboreal; anterior legs normal.

The striking character of the adult Margarodes, especially (because least expected) in the ♂, is that of the anterior legs. The ♂ of Porphyrophora has long been known to have short anterior legs; that of Margarodes was quite unknown until lately described by M. Lataste in the *Actes Soc. Scien. Chili*, Vol. VII (1897), pp. 99–102. Lataste's account, relating to *M. vitium* Giard, is quite full, and he gives a figure of one of the curious anterior legs with its thickened femur. Nobody, however, seems to have seen the insects digging until now, nor to have known the purpose of the peculiarity.

The following description will serve for the identification of the New Mexico Margarodes:

Margarodes hiemalis, sp. nov.

Adult ♀. Bright lemon yellow, very soft, oval; 5½ mm. long, 4 broad, 2½ high; segmentation distinct, each segment with a whorl of mostly blackish but inconspicuous hairs; apex of abdomen with a small reddish hairy prominence; abdomen on ventral surface longitudinally sulcate on each side, but the median area bulging, not depressed; a deep median depression between the levels of the first two pairs of legs; thoracic spiracles present as usual, but no abdominal spiracles noticed; mouth parts entirely absent; antennæ short, moniliform, light reddish brown, except segments 1 to 3, which are pallid, 8-segmented; segments 1 and 2 very short, ring-like, fully three times as broad as long, 2 smaller and not so broad as 1; 3 transversely oval, large; 4 very short and broad; the next 3 almost cordiform; the last (8th) spherical; sutures between segments 3 to 8 very deep; 8 with some long hairs at end; skin minutely papillose; a dull pinkish patch between the antennæ; legs present; first pair adapted for digging; femur excessively broad and short, forming a low rounded cone, on which is a shining red-brown rounded structure, divided by a suture in the middle; the basal part of this, which is the tibia, is broader than long; the apical part (tarsus) is continued at its apex into a stout long piceous process, which forms a digging claw. The other legs are similar in structure, but considerably smaller; the claws are all incrusted by a black substance, which on one of the middle legs forms quite a big lump.

Adult ♂. Length of body about 2 mm., of abdominal brush about

5 mm., of wing about 3½ mm. Body purplish brown, eyes and anterior part of prothorax crimson; mesothorax shining dark brown; abdomen with a median longitudinal series of transversely lengthened dark brown or blackish marks; wings ample, clear, iridescent, with a large pinkish pseudostigma. Eyes very strongly faceted. Abdominal brushes two, arising from the 7th and 8th dorsal segments, each consisting of many white threads, as in Orthezia. Antennæ brown, 10-segmented, the segments sausage-shaped, except the first two, which are short and broad; each segment with spreading hairs, which, however, are not as long as the segment. The wings have no veins except the costal, but there are three folds; two parallel and close together, obliquely crossing the middle of the wing to the lower margin; and one in the place of the anal vein. Anterior legs fossorial, the femora greatly swollen, like the hind femora of Haltica; tibia and tarsus (the latter short) transformed into a digging claw; middle and hind legs ordinary, except that the hind femora are rather swollen, and the tarsi are all extremely short, hardly one-fourth the length of the long tibiæ. Claws sharp and long; no digitules.

Hab. — Mesilla Park, New Mexico, Jan. 16, 1899. The immature forms remain to be discovered; they will certainly be found on the roots of some shrub; most probably on those of *Atriplex canescens*, which abounds on the college campus; possibly on those of *Prosopis glandulosa.*

MESILLA PARK, NEW MEXICO,
January, 1899.

EDITORIAL COMMENT.

The Gypsy Moth and Economic Entomology.—In the presidential address delivered before the Association of Economic Entomologists, last August, the motives of those who oppose the large appropriations made by the State of Massachusetts for the extermination of the gypsy moth are attributed to "unfortunate jealousy or unreasonable prejudice." In the same address the expression of individual opinion is deplored, and while diversity of view is recognized as an essential of progress, the expression of such diversity before the public is condemned.

The *American Naturalist* has more than once taken ground against the annual appropriation for the extermination of the gypsy moth, and with the keenest appreciation of the objects and aims of sound economic work is prepared to maintain that, given all the money and all the men asked for, the extermination of the insect in Massachusetts is doomed to failure. The public, always slow to accept the results of science, will regard this failure to the detriment of scientific work, and when popular support is needed the claims of science will be discredited. As a recent writer says: "Is it not sometimes the part of wisdom in a prudent business man to let a bad investment go, rather than to lose more money by trying to save what is already lost?"

The gypsy moth problem in Massachusetts may be briefly stated: Introduced in the egg stage in 1868 or 1869, the insect at first escaped general notice; in 1889, however, it caused so much destruction in Malden and Medford that the state was asked, in 1890, to take measures for its extermination. A commission was at first appointed, and served for less than a year; since 1891 the work has been directed by a committee of the State Board of Agriculture. Nearly one million dollars has been expended in the work of extermination. This work, prosecuted with more vigor than judgment, has greatly reduced the damage done in badly infested districts, but has not succeeded in keeping the insect within the original boundaries as defined in 1891. The injury caused by the cutting down of trees and bushes, the wanton destruction, by burning, of birds during the nesting season, and the general tidying up of beautiful wild country roads and ways

are features of the work of extermination that cannot be too strongly condemned. While the work for extermination is approved by the official vote of the Association of Economic Entomologists, it is unfavorably viewed by many eminent entomologists, by most scientific men living in the infested district, and by a large and rapidly increasing number of residents under the eyes of whom the work of extermination is carried on. It is also opposed by one of the original members of the committee appointed in 1891, a man deeply interested in the agricultural welfare of the state and country.

The most effective testimony against extermination and in favor of suppression is the practical experience of a resident of Medford, Mr. Walter C. Wright. Mr. Wright lives in the heart of the infested district, and has upon more than thirty acres of land, the larger part woodland, brought about "a thorough suppression, and the time and expense which have been devoted to the work are not worth naming." Mr. Wright adds: "I should blush to ask state aid for it."

In view of these facts, is it worth while to continue the present extravagant policy? We answer emphatically, No!

The common-sense view—and it was Huxley who said that science is but common sense applied to common things—was pointed out several years ago, and has been frequently repeated. It may be summed up as follows:

1. Abandon the policy of extermination, and turn all resources towards the suppression of dangerous outbreaks.

2. Formulate a law for the suppression of all insect and fungus pests. Employ a corps of men to point out to landowners and to town and city authorities the proper mode of coping with dangerous pests.

If the landowners or the authorities fail to observe the law, after proper notice, the work should be done by the state at the delinquent's charge. To enforce this law the employment of from ten to twelve men, with an annual appropriation of $50,000, will suffice. The work should be under the charge of the State Board of Agriculture.

The advocacy of one view for ourselves and one view for the public requires no comment.

Zoölogical Instruction in German and American Universities.— There is one very marked difference between the German and the American universities in regard to what belongs to the field of zoölogical instruction. In Germany a student would rarely think of going to the professor of zoölogy for instruction in matters relating to the vertebrates. He would nearly always turn to the professor of

anatomy in the medical faculty for direction in such studies, since with few exceptions the professor of zoölogy is interested solely in the non-vertebrate groups or in the problems of cytology. In America the conditions are widely different. The professor of zoölogy here has to cover both vertebrates and invertebrates, while the student who should go to the anatomical departments of the medical schools would get nothing but human anatomy, and absolutely no breadth of view. So far as we are aware there are but two medical schools in the whole United States where this is not true. With but very few exceptions, the professors of anatomy know nothing of any vertebrate except man, but are usually in the position of that professor who said recently, while studying the lateralis branch of the vagus in the shark, that he was all wrong in calling that nerve a branch of the tenth, because the tenth nerve was distributed only to heart, lungs, and stomach. Had our medical schools professors with broader perspectives, the study of anatomy would have more attractions for the students, and the examinations would no longer be puzzles, but would be of value in testing the real knowledge of the student. In many medical schools in this country the stock question asked in examination in osteology demands a description of either the sphenoid or the petrous portion of the temporal bone, regardless of the fact that these bones are of very little practical importance to the future practitioner. We would not urge our zoölogists to narrow their field, but we would recommend to our professors of anatomy that they make their instruction and their studies comparative. Our medical schools are absolutely unproductive in the field of anatomy; almost all work done on the anatomy of vertebrates in Germany is done in the medical departments of the universities.

Aberrant Birds' Eggs.— Some time ago Professor Bumpus showed us that the eggs of the English sparrow in America are variable as well as the adults, and now Mr. J. W. Jacobs points out that the eggs of many of our species vary greatly in coloration, size, and shape. Aberrations of one sort or another are recorded in one hundred and ten species, and several cases are represented by photographic reproductions on two plates. Here is a better occupation than naming new subspecies. We hope Mr. Jacobs's pamphlet will be widely read, and that oölogists will be incited not to gather more birds' eggs, but to *study* the vast collections which have already been made. Mr. Jacobs's pamphlet is entitled "Oölogical Abnormalities," and is published by him at Waynesburg, Pa.

Are Bird Migrations Affected by an Extreme Southern Winter? — The extraordinary cold, combined with snow, which affected the Southern States February 8 to 14, undoubtedly had a very destructive effect on the birds of that region. A correspondent of the *Boston Transcript* sends to that paper the following clipping from the *Charleston* (S. C.) *News and Courier:*

"On Tuesday a gentleman flushed a woodcock in the neighborhood of the City Hall, and a little later in the day a colored man captured one on Broad Street. The poor bird was too cold to make much use of its wings to effect its escape. At Mount Pleasant numbers of them, together with quail, were found near the habitations of men, and caught. They were evidently driven in from the fields and woods by cold and hunger, and thus made themselves easy victims to the pot hunter. More than half a dozen negroes were seen yesterday with large bunches of birds, consisting of quail, woodcock, and doves, which they had found, no doubt, in a partially frozen condition. This illustrates how even the wildest creatures are sometimes driven by extreme cold and hunger to take the most desperate chances in search of food, and how for the time they become as tame as domestic animals and birds. No doubt there will be a great scarcity of game another year, for large numbers of the smaller animals and birds, especially birds, must have perished from the intense cold of the last few days."

Have any students of this spring's migrations noticed any diminution in the number of birds?

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

The Neolithic Period of Human Culture in Northern Africa. — The February number (Feb. 15, 1899) of the *Revue de l'École d'Anthropologie* presents under this title an able article from the pen of Professor Zaborowski, the Archivar of the Paris School of Anthropology.

The author reviews numerous observations and arrives at the conclusion that, during the neolithic period, the peoples of the whole of northern Africa, including Egypt and a large part of the desert, were racially, as well as by their civilization, closely interrelated.

Who these ancient North-Africans were, ethnically, is not certain. Among the most ancient Egyptian skulls there are none of negroes, and hence the prehistoric Egyptians were not Asiatics who invaded new regions, driving away the black indigenes. Later on, negro skulls appear, indicating an early slave trade.

Not much is known yet of the neolithic period in Sahara and Algiers; nevertheless there were known, as early as 1883, seventeen ancient stations in the Sahara, where stone implements were found. The finds generally yielded numerous knives and saws, some arrow points, scrapers, etc., some of the specimens showing considerable art; there were also commonly found fragments of large ostrich eggs, some of these pieces being in the form of ornaments. Also fragments of black ornamented pottery were found. These articles were used at a time when the Sahara was watered by rains and had an abundant vegetation. Near the wells of El-Hassi the specimens lie in a layer of mud, under a layer of sedimentary limestone 50 cm. in thickness.

The stone implements are found principally between Laghouat and El-Golea, at Aïn-Taïba, and in the vicinity of Ouargla. The natives of these places know nothing of the origin of these articles, and declare that they are the weapons of the spirits of the air, the "djinn." Large shops where the implements were made have also been discovered, and in these shops division of labor was noticeable. Axes are extremely rare, and those that are found were probably brought in by trade.

The population of Sahara never attained the density, or the height of culture, of the Egyptians; nevertheless, no line of demarcation between the two peoples is apparent during the neolithic period.

Discoveries similar to those in Sahara were made in Algiers and in Tunis. Oran was particularly rich in specimens. In Tunis the silex stations and shops are quite numerous. In the oasis Métouïa, north of Gabes, Mr. Belucci, in 1875, found over 1700 arms and implements of stone. He also found nearly 3000 specimens at Gabes itself. Since then a number of other important finds have been made in these regions. The characters of the implements are very nearly like those from the Sahara, and similar characters are observed on stone implements from Egypt. Axes and polished articles are rare.

The modes of burial are much alike throughout northern Africa. We meet with several distinct methods. The most ancient burials were like those of many American peoples, the body being buried with its head bent down and the lower limbs folded towards the body — in the shape of the fœtus in utero. This mode of burial occurs from Egypt to the extreme limit of western Africa (Cape Spartel); it is still preserved by the Guanches.

Somewhat later, bodies were buried in cysts or fosses, made from beaten clay or from sun-dried bricks. Still another form of burial consisted in enclosing the body in one or two large earthen jars — a method which was practiced in some parts of Central America. These kinds of burial were also found to be common to various parts of northern Africa. The jar burials are particularly prominent in Tunis and Algiers, where they seem to have been practiced for a longer period of time than in Egypt. At Carthage, jar sepulchres date from as late as the early Punic epoch. This form of burial is also found in parts of Spain, in Corsica, and Balearic Islands. The period of such graves is throughout anterior to the use of iron, though embracing in places the periods of copper and bronze.

Still another class of works which supports the theory of close connection of the prehistoric populations of the whole of northern Africa are the petroglyphs. These are found from Morocco to the Libyan desert. The engravings in the rock are often of large size, and represent the figures of plumed hunters or warriors, and of many animals, some of which have been for a long time extinct in these localities. There are no representations of horses, asses, camels, or sheep, from which it may be concluded that the petroglyphs antedate the introduction of these animals and are very ancient. They are closely allied to the *graffiti* of the higher Egypt and of a part of

the desert (between Edfou and Silsilis). Zaborowski considers these petroglyphs to be symbolical, and for the most part more ancient than the Egyptian hieroglyphs, to the formation of which they possibly led.

Thus the ancient populations of northern Africa present three very important phases of culture in common, namely, similar implements, the same burial costumes, and similar rock-engravings. This establishes the fact that the neolithic populations of northern Africa were closely interrelated, more so than the peoples living in the same regions since the stone period.

It is to be hoped that this excellent dissertation by Professor Zaborowski will soon be followed by a comprehensive study of the osseous remains of the ancient inhabitants of northern Africa.

HRDLICKA.

Prehistoric Art.[1] — In a profusely illustrated monograph Dr. Wilson gives an exhaustive account of our present knowledge concerning the art of prehistoric peoples. "This paper is a contribution to the history of art rather than to the science of art, and is intended as a record of the actual manifestations of art in the various epochs of human culture in prehistoric times, showing the earliest specimens, and thus presenting the idea indicated in the title."

The author has confined his attention to known facts, and submits these as a foundation upon which others may theorize if so inclined. He has rendered a great service to archæology in thus gathering together such a wealth of information, and his profound knowledge and experience in this department of science would have warranted him, if any one, in indulging in speculations regarding the cultural stages indicated by the artifacts described. The work is divided into three sections: I. Paleolithic Period; II. Neolithic Period; and III. Prehistoric Musical Instruments; the last having been prepared jointly with Mr. E. P. Upham.

F. R.

The Lamp of the Eskimo.[2] — This paper is announced to be one of a series upon "heating and illumination from the standpoint of the ethnologist." The uses and importance of the lamp are described,

[1] Wilson, Thomas. Prehistoric Art: or the Origin of Art as manifested in the Works of Prehistoric Man, *Report of the U. S. National Museum* for 1896, pp. 349–664. Government Printing Office, 1898.

[2] Hough, Walter. The Lamp of the Eskimo, *Report U. S. National Museum*, 1896, pp. 1027–1057.

and the fact pointed out that it has probably been the cause of the occupancy of the Arctic regions by the Eskimos — has determined the distribution of the race. It is peculiarly the property of the women, and "a woman without a lamp" is an expression which betokens, of all beings, the most wretched among the Eskimo. Owing to the soot thrown off, the lamp renders it impossible for the Eskimo to be at all cleanly in the igloos. The lamp fulfills several functions, one of the most important of which is to melt snow and ice for drinking-water. There are three kinds of lamps: house lamp, traveler's lamp, and mortuary lamp. About a dozen types are described, from the East Greenland lamp to that from Siberia. In both the Labrador and the Mackenzie River type it would seem to us that the author has attempted to establish a "type" from too small a series. The Peabody Museum of Harvard University contains several large Labrador lamps from Hopedale, which have divided bridges, and thus differ somewhat from the two types accredited to that region. But the significance of the paper lies in its demonstration of the effect of a technic art upon a hunting race; it is a contribution to the final "Weltgeschichte." F. R.

Chess and Playing Cards.[1] — Though it has developed from a simple catalogue and purports to be but a preliminary work, this memoir of 263 pages, by Stewart Culin, contains a valuable store of information concerning games and divinatory processes. In the words of the author, "The object of this collection is to illustrate the probable origin, significance, and development of the games of chess and playing cards." "The basis of the divinatory systems from which games have arisen is assumed to be the classification of all things according to the four directions. This method of classification is practically universal among primitive people both in Asia and America. In order to classify objects and events which did not in themselves reveal their proper assignment, resort was had to magic. Survivals of these magical processes constitute our present games. The identity of the games of Asia and America may be explained upon the ground of their common object, and the identity of the mythical concepts which underlie them. These concepts, as illustrated in games, appear to be well-nigh universal. In the classification of things according to the four quarters we find a numerical ratio was assumed to exist between the several categories. The dis-

[1] Culin, Stewart. Chess and Playing Cards, *Report of the U. S. National Museum* for 1896, pp. 665–942. Washington, Government Printing Office, 1898.

covery of this ratio was regarded as an all-important clue. The cubical dotted die represents one of the implements of magic employed for this purpose. The cubical die belongs, however, to a comparatively late period in the history of games and divination. The almost universal object for determining number, and thence, by counting, place or direction, is three or more wooden staves, usually flat on one side and rounded upon the other." The author offers no comments upon the games of Patolli, of Mexico, and Pachesi, of India, which are perhaps the best examples of resemblance in a somewhat complex game from widely separated regions. It will be remembered that Dr. E. B. Tylor, to whose paper he refers, considers the game of Patolli to have been derived from Asiatic sources. The work is illustrated with fifty plates and over two hundred figures in the text.

F. R.

The Huichol Indians of Mexico.[1] — Carl Lumholtz has given a preliminary sketch of the Huichol Indians of the state of Jalisco, Mexico, whom he visited in 1894. But brief mention is made of their physical characters. The average stature of 43 men measured was 1.65 meters. They are thievish, emotional, imaginative, excitable, avaricious, and yet not inhospitable when their confidence has been gained. They spend a great part of their time at feasts and ceremonies. The houses are of stones and mud, covered with thatched roofs. The drinks used and the manner of brewing and distilling them are described in some detail. The author considers the process of distillation to be the most primitive in use upon the continent.

F. R.

Anthropological Notes. — In the *Annual Report of the Director of the Field Columbian Museum* for the year ending Sept. 30, 1898, we note that the Department of Anthropology was one of the most active and successful in the museum during the year. The accession list contains a rather undue proportion of osteological specimens — rather a fortunate condition from our point of view.

In the January–February number of the *American Antiquarian* H. I. Smith gives an interesting list of the "Animal Forms in Peruvian Art." The animals represented range from man to mollusks, and are both painted and sculptured.

[1] *Bulletin of the American Museum of Natural History*, vol. x, article i, pp. 1–14. New York, 1898.

In an able review of "Notes of the Folk-Lore of the Fjort" (R. E. Dennett), Mr. Newell, in the October–December number of the *American Folk-Lore Journal*, calls attention to the fact that in the publication of this work the Folk-Lore Society places itself on record as accepting his definition of the scope and meaning of folk-lore. It is not to be confined to survivals of custom and belief among enlightened races, but is to include all oral tradition of all periods and all cultures.

In the *Ann. de la Soc. Esp. His. Nat.*, ser. 2, tome vi, is published a bibliography of anthropological literature relating to the Spanish peninsula for the years 1896 and 1897. Sr. Hoyos has given 113 titles for the former year and 127 for the latter. They are classified under the following heads: general anthropology, ethnography, and sociology, linguistics, and prehistoric and protohistoric archæology. They are further classified according to the provinces to which they refer.

Marquis de Nadaillac, in the November–December number of *L'Anthropologie*, gives an extended review of an "Introduction to the Study of North American Archæology" by Cyrus Thomas. His distinguished investigations in this field entitle him to speak with authority concerning all that pertains to prehistoric America. He justly observes that the subject is one of great interest because of the obscurity enveloping it, and, in conclusion, "the past of America is still an unfathomable mystery."

In the *Smithsonian Report* for 1896 will be found a description of the "Biblical Antiquities" that were exhibited at the Atlanta Exposition in 1895. This illustrated paper is of special interest to students of "Ceremonialism."

F. R.

GENERAL BIOLOGY.

Professor Ewart's Mares.[1] — Lord Morton's mare has played its part in the literature of speculative biology for nearly eighty years, and deserves a rest. It is most likely to get it through the researches of Professor Ewart, who is conducting telegony experiments on a large scale at his farm at Penycuik [pronounced *pennycook*]. Since the

[1] Ewart, J. C. *The Penycuik Experiments.* London, Adam and Charles Black, 1899. xciii + 177 pp., 46 figs.

quagga, which Lord Morton used in "infecting," is now an extinct species, Ewart uses zebras. He has bred, up to the time of writing, nine zebra ♂ horses, ♀ hybrids, and three reciprocal hybrids. In two cases he has crossed a mare with a zebra, and then obtained a second foal from the mare mated with a horse. In one case there were quite marked stripes; in the second case there were faint and few stripes. In two other cases a mare which had already had foals by a horse and then by the zebra, had a third foal by a horse, and this foal was unmarked. Ewart does not regard the stripes seen in the first two cases good evidence for telegony, because of the frequency with which such stripes occur on pure-bred foals. He finds that foals are far more often marked with stripes — apparent or real — than is generally supposed, and that stripes will be often seen in horses if they are carefully looked for. Ewart is continuing his experiments; but it seems as though the fact that even marked stripes may occur in normally bred foals will interfere with getting a satisfactory conclusion concerning telegony in horses.

Common Salt a Plant Poison. — A solution may have either of two injurious effects: it may act osmotically and withdraw from the protoplasm the necessary water; it may act chemically. Sodium chloride has usually been regarded as acting osmotically only. Now True [1] shows that when a solution of sodium chloride or potassium nitrate is made of the same osmotic value as a sugar solution, it is far more injurious than the sugar solution. This can only be interpreted to mean that the salt has some additional effect above the osmotic effect, and this can only be a chemical one.

Physics and General Biology. [2] — The naturalist has frequent need of a good physics. We therefore take pleasure in noticing a new text-book on this subject by two professors at Yale University. The treatment, while quantitative, does not involve the use of calculus. Of most use to the naturalist will be the sections on instruments for measuring time and length; tables of densities of gases at various temperatures and pressures and of solids and liquids; surface tension, to which an entire chapter is devoted; solutions (including a fairly full treatment of osmosis); electric cells and galvanometers;

[1] True, R. H. Physiological Action of Certain Plasmolyzing Agents, *Bot. Gazette*, vol. xxvi, pp. 407–416, December, 1898.

[2] Hastings, Chas., and Beach, F. K. E. *A Text-Book of General Physics.* Boston, Ginn & Co., 1899. viii + 768 pp., 495 figs.

the electric theory; waves, especially sound waves; the physical theory of hearing and musical instruments; and valuable chapters on Elementary Theory of Optical Instruments, Spectroscopy, and Maximum Efficiency of Optical Instruments.

The Plankton of the Limfiord.[1] — This fiord is a tortuous channel, 92 miles in length, which traverses the peninsula of Jutland. In 1825 an irruption of the North Sea drove back the fresh and brackish water fauna of the fiord and replaced it with that of the sea. A slow current passes through it from the east or the west according to the relative levels of the North and Baltic Seas, though in recent years it has been predominantly from the North Sea eastward. The stream is shallow — 2–13 fathoms — with a few expansions in shallow lakes, and exhibits practically uniform conditions of temperature and salinity at the top and the bottom. Owing to the slight depth the temperature rises to 18.4° C. in the summer, and the salinity averages about 3 per cent. The plankton of this interesting region has been investigated by Dr. Petersen of the Danish Biological Station. Three traverses of the fiord were made in 1896 and 1897, and the collections thus made were supplemented by a seasonal series and by others from the Cattegat and the Baltic. The qualitative examination, made by Mr. H. Grau, was confined in the main to the diatoms and the Peridinieæ, which constitute the bulk of the plankton. The investigation determined that the amount of plankton per □ meter in the shallow fiord was 10–50 times as great as that of the adjacent and deeper North Sea, and more than double that of the Cattegat. The constitution of the plankton is peculiar in that the predominant species are neritic rather than oceanic, and are not thus abundant in the North Sea, whence the fiord receives its water, nor in the Cattegat, into which it empties. Its diatom flora must therefore breed in the water in transit in response to some change in the physical-chemical environment, as, for example, contact with the bottom, rise in temperature, or the addition of nitrogen by the tributary rivulets. Another instance of this unique phenomena — namely, the maintenance of a peculiar plankton at a given point in a body of water traversed by a current — was discovered in the Cattegat, where an undercurrent from the deeper Skager Rack enters this shallower area, and there is developed within it, in passing, a local and peculiar diatom flora. The results of this work lead the author to suggest that "guide

[1] Petersen, C. G. J. Plankton Studies in the Limfjord, *Rep. Danish Biol. Station*, vol. vii, 1897. 23 pp., with 1 map and 4 tables. 1898.

organisms" from the plankton for the detection of oceanic currents, especially with changing shore conditions, should be chosen with care.

C. A. K.

PHYSIOLOGY.

Ocular Accommodation. — For several years past Dr. Theodor Beer,[1] of the University of Vienna, has been investigating ocular accommodation in those animals which possess well-developed camera eyes, and has presented in a lecture before the Fourth International Congress of Physiologists an admirable survey of this subject. According to him such water animals as the dibranchiate cephalopods and the bony fishes possess eyes which in the resting condition are accommodated for short distances, and which require active accommodation for vision at long distances. This is brought about by shifting the lens, without changing its curvature, from a distant position to one nearer the retina. In the cephalopods this shifting is accomplished by the contraction of a ring-shaped muscle which works against the deeper contents of the eyeball. In the bony fishes a band-like muscle, the retractor of the lens, draws that body inward toward the retina.

In the air-inhabiting vertebrates the resting eye is accommodated for distant vision. Near vision is possible only by active accommodation. This is accomplished in one of two ways: either the lens, unchanged in form, is moved away from the retina, as in amphibians and most snakes, or the convexity of the outer surface of the lens is increased, as in a few snakes, the turtles, crocodiles, lizards, birds, and mammals. The outward movement of the lens is brought about by an increase of pressure in the vitreous humor, produced by muscular contraction; the change in the convexity of the lens is induced by the well-known indirect action of the ciliary muscle.

In all the groups of animals examined, with the exception of the cephalopods and the birds, some species were found in which accommodation was entirely or almost entirely absent; such, for instance, was the case in the cartilaginous fishes, the sea eels, haddock, frogs, toads, salamanders, alligators, some lizards, vipers, and many rodents. Many of these are night animals, and possess in the daytime so small

[1] Beer, T. Die Accommodation des Auges in der Thierreihe, *Wiener klinischen Wochenschrift*, Nr. 42, Jahrgang 1898.

a pupil that the images on their retinas are formed by this opening rather than by the lens, which is thus in a measure functionless.

Most vertebrates are unable to accommodate their eyes so that they can see equally well in water and in air. Water animals when in the air are extremely shortsighted ; air-inhabiting forms when in water are very farsighted. Only some few vertebrates, such as the pond turtles which seek their prey both by land and water, seem to see well on land and yet accommodate for near vision in water.

Those animals that accommodate by moving their lenses (cephalopods, fish, amphibia, and some snakes) presumably suffer no special loss of this power as age advances. Those whose accommodation depends upon a change in the form of the lens, brought about through its elasticity (most reptiles, birds, and mammals), probably suffer as the human being does, and become permanently farsighted as age advances.

G. H. P.

The Sense of Hearing is the subject of a popular discourse delivered by Dr. K. Vohsen[1] before the Senckenberg Natural History Society and published in their proceedings. The speaker calls attention to the relation between speech and hearing, and shows in a table the zoölogical distribution of sound-producing and sound-perceiving organs. While almost all animals possess the latter, only arthropods and vertebrates possess the former. The auditory vesicles of the invertebrates, as well as the inner ears of the vertebrates, are described. Only a hint is given that the so-called auditory organs of the lower animals may also be concerned with the function of equilibration, and no mention is made of the fact that, in the cases most carefully examined, equilibrations seem to be the exclusive function of these parts. The lecture contains an excellent table showing the range of hearing in the human ear, and the complex question of the analysis of sound by the ear is considered.

G. H. P.

Physiology for Schools. — In a little book of Laboratory Exercises[2] Mr. James Edward Peabody has done a good work, for which many teachers will be grateful. By series of skillfully framed questions upon objects readily accessible, the pupil is led to exert his

[1] Vohsen, K. Über den Gehörsinn, *Bericht d. Senckenberg. naturf. Gesell.*, 1898, pp. 91–112.

[2] Peabody, J. E., Instructor in Biology in the High School for Boys and Girls, New York City. *Laboratory Exercises in Anatomy and Physiology.* New York, Henry Holt & Co., 1898. Cloth, x + 78 pp., interleaved.

powers in making simple yet significant observations, experiments, and inferences which cannot fail to awaken a lively interest. Certain of these exercises are intended to be performed by the pupil at home and reported on in class. Others involve a demonstration by the teacher before the class. Not the least valuable feature is a series of questions to be used in making a "Comparative Study of the Mammalian Skeleton," as shown in such a collection as that of the American Museum of Natural History. This points the way to a wider educational use of museums in large cities. The book is full of helpful suggestions.

The only passages noticed as calling for amendment are the following: On p. 62 the pupil is directed to "prepare a strong solution of quinine in water by dissolving sulphate of quinine in water by the aid of sulphuric acid." This is hardly explicit enough for home use. Moreover, sulphuric acid in inexperienced hands seems unsafe. In the directions for applying "the nitric acid and ammonia test" (p. 22) the boiling necessary to secure the xantho-proteic reaction is not mentioned.

FREDERICK LEROY SARGENT.

Overton's Physiology.[1] — It is not often that we find so much nonsense compressed into a small volume as a casual glance reveals in this one. A few extracts will show the character of the whole volume. "In moist earth there lives a little animal called the *ameba*." "All animals must have water to drink." "*Oil*, or *fat*, is found in little pockets between the cells." "The fat around the cells is like a cushion, which protects the cells and keeps them warm." Starch grains "dissolve in water and form a paste." "When the plant ripens, the starch changes to sugar." "Most of the fat is oxidized in the lungs." The mind "tells the liver cells to change the digested food to blood." "The mind lives in a few cells and rules all the rest." "From the cells [of bone] there go out fine strings of connective tissue. Lime is mixed among the strings like starch among the fibers of a linen collar." Between the vertebræ "are thick, strong pads of tough flesh or gristle." The scapula "is not joined to any bone." "A muscle is large at one end and is fast to a bone." "The power of a muscle comes from the heat of oxidized food." "Cell, the smallest part of the body which can live when separated from the rest." "The only cells of the body which can move about are the white blood cells. The rest are held in place by strings of

[1] Overton, Frank, A.M., M.D. *Applied Physiology, including the Effects of Alcohol and Narcotics.* New York, American Book Company, 1898.

connective tissue." "The liver cells also change sugar into a kind of starch. This is soon oxidized in the liver, and heat is produced for the use of the body." And so on *ad nauseam*.

Animal Hypnotism.[1] — The first part of Professor Verworn's *Contributions to the Physiology of the Central Nervous System* is taken up with an interesting account of the so-called hypnotism of animals. As early as 1636 Schwenter described the well-known experiment in which a hen is held on a horizontal surface, and a chalk-line drawn from her head over the surface; on releasing her, instead of recovering her normal position, she may remain motionless for some considerable time. Ten years later Kircher described the same experiment, except that he directed that the hen should be bound with a cord and part of the cord stretched in place of the chalk-line. On drawing the chalk-line the cord could be removed, leaving the hen motionless. In 1872 Czermak showed that the cord and chalk-line were superfluous, and that the experiment succeeded perfectly well without them. He likewise called attention to similar phenomena in the crayfish. The next year Preyer published experiments of a like nature on the guinea pig and frog. These were followed by contributions from Heubel and from Danilewsky, both of whom worked chiefly with the frog. As a result of these studies it was found that many animals, chiefly vertebrates, when placed in abnormal positions and held there till their struggles to recover had ceased, would remain motionless in some cases for an hour or more, especially when they were protected against strong sensory stimuli.

Schwenter believed the animals remained still from fright, and this idea was elaborated by Preyer. Kircher thought that the hen, knowing she was bound, believed it useless to resist, and therefore lay still. After the removal of the cord she mistook the chalk-line for the cord, and, believing she was still bound, made no effort at recovery. Czermak, and later Danilewsky, regarded the condition as directly comparable with the hypnotic state of the human subject. Heubel sought for an explanation of the phenomenon in conditions parallel with sleep.

In dealing with this subject Verworn considers three questions: first, what is the pose of the body and the condition of the musculature when the animal is "hypnotized"? secondly, to what extent is

[1] Verworn, Max. *Beiträge zur Physiologie des Centralnervensystems.* Erster Theil. Die sogenannte Hypnose der Thiere. Jena, G. Fischer, 1898. iv + 92 pp., and 18 illustrations in the text.

it open to sensory stimulation? and, thirdly, what part of the central nervous system is essential to this state? Answers to these questions are obtained from observations on guinea pigs, hens, frogs, and asps.

The postures which the "hypnotized" animals assume represent usually some step in the process of recovering from their abnormal positions, and they are held in these positions by a tonic contraction of their muscles. They are, so to speak, like so many instantaneous photographs of animals, in process of righting themselves. Verworn believes that the reason they remain motionless in this condition is not because their motor impulses have been inhibited, but simply because there are no such impulses.

In the "hypnotic" condition the animals' senses are normally acute, but their reflex capabilities are probably actually reduced, though the loss of this power may in part be due to exhaustion.

Heubel found that the experiments made on the frog could be performed as well on an animal without its cerebral hemispheres as on one in normal condition. This important observation has been confirmed by Danilewsky and by Verworn, and the latter has demonstrated the same to be true for the hen. In the hen, however, the presence or absence of the cerebrum makes a difference. While in both cases the animals may be brought into a motionless condition, a hen without a cerebrum will remain motionless an hour or more, instead of ten minutes, as in the normal animal. Moreover, her recovery is always associated with some obvious sensory stimulation, which is not necessarily so in the case of the normal hen. Guinea pigs whose spinal cords have been cut respond to the assumed hypnotic influence only by the anterior portions of their bodies. From these experiments Verworn concludes that the center for readjusting the position of the body, as well as that for the tonic contraction of the muscles, cannot lie in either cerebrum or cord, but must be somewhere between these parts. He assumes with reason that it is located in the cerebellum. It is remarkable, however, that Verworn has not attempted to test this assumption by trying experiments on animals from which the cerebellum had been removed.

According to Verworn the motionless condition of the animals is dependent upon two factors — a tonic stimulation of the cerebellar reflex center, whereby the animal is held in an attitude of recovery, and an inhibition of the motor areas of the cerebrum. As the cerebrum acts only in this negative way, an animal without its cerebrum may be made motionless by the positive action of its cerebellar cen-

ter. In recovery the animal without its cerebrum is dependent upon its sense organs to generate impulses which may eventually affect its cerebellum, while the normal animal may have its cerebellum influenced not only through its sense organs, but also from its centers for spontaneous movements in the cerebrum. Thus animals with a cerebrum usually recover sooner than those deprived of this organ. The motionless condition in animals has then only a superficial resemblance to certain phases of hypnotism as seen in the human subject, and probably is an essentially different phenomenon.

G. H. P.

ZOÖLOGY.

Generic Names Preoccupied. — Dr. Carlos Berg has done a useful work in a critical study of recently proposed generic names with a view to the elimination of those preoccupied. In *Communicaciones del Museo Nacional de Buenos Aires*, 1898, pp. 41, 43 (December 17), he proposes to substitute the following names of animals for others preoccupied. Hoferellus for Hoferia; Iheringiana for Iheringiella; Halochnaura for Asterope; Gestroana for Gestroa; Corynophora for Halterophora; Meyrickella for Prionophora; Walsinghamiella for Gilbertia (Lepidoptera); Watsoniella for Watsonia; Schochidia for Lophostoma; Braunsianus for Anelpistus; Gilbertidia for Gilbertina; Matæocephalus for Cœlocephalus. The last two are genera of American fishes.

D. S. J.

Deep-Sea Fishes of Iceland. — Dr. Christian Lütken has just published, in English, a most valuable account of the fishes dredged by the "Ingolf" in 1895 and 1896 off Iceland and the Faroë. Forty-four species are recorded, three of them new, *Raja ingolfiana*, *Cyclothone megalops*, and *Macrurus ingolfi*. Important notes are given on the structure of different species. The lithographic plates of Cordts (some of them colored) which illustrate this paper are most excellent.

D. S. J.

Spolia Atlantica. — Dr. Christian Lütken, of the University of Copenhagen, has continued his most valuable discussion of the early stages of development of fishes, as shown by the rich "spoils of the Atlantic," young fishes taken in the open sea. The third paper of

this series, just published by Dr. Japetus Steenstrup and Dr. Lütken, treats of the development and structure of the "Molidæ, or Head-fishes," called by them "Klumpfish," or "Moon-fish," the family constituting the two genera Mola and Ranzania.

The changes which take place in the growth of these fishes are most remarkable, and have led to the establishment of very many (thirteen) nominal genera, besides the two which have a real basis in adult structure. The most persistent of these genera was the diminutive Molacanthus, a stage of growth which was naturally and apparently logically taken for an adult fish.

This paper, like all of Dr. Lütken's, is very conscientiously written and admirably illustrated.

We miss, however, the usual "Résumé en français," an important help to those whose knowledge of Danish is casual and incomplete.

D. S. J.

Fishes of New South Wales. — The government of New South Wales has lately published a review of trawling operations of H. M. S. "Thetis," conducted along its coast by Frank Farnell.

The record, valuable for economic purposes, is supplemented by a "Scientific Report" on the fishes by Edgar L. Waite. In this report numerous species are enumerated, two of them new to science, with fairly drawn figures by Mr. Waite.

The nomenclature is very antiquated, the author apparently depending almost entirely on *Günther's Catalogue of the Fishes of the British Museum*, the one published volume of Boulenger's masterly catalogue being ignored. There is reason to doubt the accuracy of certain identifications. The new species are as follows: *Histiopterus farnelli*, *Chimæra ogilbyi;* but doubtless others will appear when the material has been more critically studied. D. S. J.

Fresh-Water Ostracoda of South America. — The fresh-water collections made at Montevideo, in the Straits region, and in Chili by the Hamburg Expedition, have been examined for Ostracoda by Dr. W. Vavra[1] of the Prag Museum. He finds but eight species, three of them being well-known cosmopolites, while the remaining five are described as new. The list of Ostracoda known from South America is thereby increased to twenty-six. One species is added to the subgenus Chlamydotheca, a group characteristic of the southern

[1] Vavra, W. Süsswasser-Ostracoden, *Hamburg. Magalhaensische Sammelreise.* 26 pp., 5 Abb. Hamburg, 1898.

hemisphere. Species of this genus have been reported from Ceylon and South Australia, from Patagonia, the Falkland Islands, Argentina, Brazil, Venezuela, and from Vera Cruz, Mexico. A single species only has been found in the temperate regions of the northern hemisphere, having been described by Turner in 1892 from Cincinnati as *Cypris herricki.* Dr. Vavra now regards this as identical with *C. speciosa* Dana, described in 1838 from Rio de Janeiro. The genus Notodromas also receives an addition from South America in *N. patagonica.* Two of the three species of this genus previously known belong to the South Australian region, and one is cosmopolitan in its distribution. Dr. Vavra's paper thus affords further data for the oft-recurring discussion of the similarity of the southern fauna of the eastern and western hemisphere.

C. A. K.

New Flagellata from the Rhine.[1] — Eight new forms are described by Dr. Lauterborn from the Rhine and its adjacent waters. Of especial interest is his *Bicosœca socialis*, a free-swimming colony in which each zooid exhibits a well-defined but rudimentary collar about the single flagellum, a condition which suggests a possible origin for the Choanoflagellata. A colonial Chrysomonad, *Hyalobryon ramosum*, is sessile, differing in this respect from the closely allied Dinobryon, which is pelagic in habit. Hyalobryon is also peculiar in the method of attachment of the superposed loricæ, these being fastened by their basal tips to the outside of the supporting lorica. Lauterborn suggests the possibility that this form may be identical with *Epipyxis socialis*, described by Dr. A. C. Stokes[2] from New Jersey. The absence in this latter description of any reference to the method of attachment of the loricæ and to the characteristic growth rings on their distal ends seemed to justify the establishment of a new genus for the species from the Rhine. A new pelagic colonial form, *Chrysosphærella longispina*, resembles *Synura uvella* in the form of the colony and in the structure of the individual zooids, but differs from the latter in the fact that each zooid bears but a single flagellum, and in addition a pair of long silicious tubes which project considerably beyond the colony. They rise from pedestals shaped like wine-glasses, and resemble somewhat the spines of the heliozoan Acanthocystis. As floats they may assist in the pelagic habit.

C. A. K.

[1] Lauterborn, R. Protozoën-Studien. IV. Theil. Flagellata aus dem Gebiete des Oberrheins. *Habilitationsschrift Univ. Heidelberg.* 37 pp., 2 Taf. Ludwigshafen am Rhein. 1898.

[2] *Proc. Amer. Phil. Soc.*, vol. xxvii (1890), p. 76.

Pond Infusoria.[1] — The activity of the Bohemian fresh-water biological station is manifested by Švec's paper on the Infusoria of the Unterpočernitzer pond. Workers in fresh-water fauna will welcome the very full biological and systematic treatment of an hitherto much neglected field of investigation. Pelagic Infusoria are represented by but seven species, three of which are described as new. *Codonella lacustris* alone occurs throughout the year, being found under the ice in the winter and reaching a maximum in the spring. The lowering of the temperature of the pond during the summer by an influx of rain water is followed by a rapid increase in the number of this species. Littoral Infusoria abound, not only among the aquatic vegetation and the diatoms alongshore, but also in the surface scum which gathers in such regions. The greater part of the sixty-nine species recorded in the paper occur in this region. The bottom fauna contains but few individuals belonging to but six species. In all, ten new species are described.

C. A. K.

Variation in Veneridæ.[2] — The result of work on 1000 specimens of a Western representative of the large Veneridæ from many localities is another illustration of the extreme variation, not only in color tint but in color scale and color pattern, which may exist in an otherwise very well demarcated form. Sixteen varieties based on color are described and arranged in six groups. These varieties are not traced to their relations with environment, though all forms, except those based on the number of rays, are said to be highly local. The varieties would appear to be discontinuous; *e.g.*, Mr. Stearns appears to indicate that the number of rays is either just about the typical twenty or "very many" more or "very many" less. It is interesting to note that the two valves vary independently of each other. In fact, it would seem from Mr. Stearns's description that one valve might be *Cytherea crassatelloides var. pauciradiata*, while the other was *C. crass. var. multiradiata*. With this extreme variation in color goes extreme stability of form and interior coloration. The only variety of form noted is in degree of ventricosity and elongation, clearly correlated with an exposed habitat calling for deeper burrowing and consequent elongation of siphons.

[1] Švec, F. Beiträge zur Kenntniss der Infusorien Böhmens. I. Die ciliaten Infusorien des Unterpočernitzer Teiches, *Bull. Int. Acad. d. Sci. Bohême* (1897), pp. 1–19, Tab. I, II.

[2] Stearns, R. E. C. Notes on Cytherea (Tivela) crassatelloides Conrad, with Descriptions of Many Varieties, *Proc. U. S. Nat. Museum*, vol. xxi (1898), pp. 371–378, Pls. XXIII–XXV.

We think the main value of the work is its illustration of the worthlessness of exterior coloration in shells to the systematist, and the interest of this ornamentation problem as an independent question of physiology, or possibly of morphology.

F. N. BALCH.

Distribution and Variation. — In the *Procès Verbaux Soc. Roy. Malacol. de Belgique* meeting of February, 1898, is reported an interesting discussion on "L'Émigration considérée comme facteur de l'évolution et de filiation des espèces." It was *apropos* of a paper by M. Arnold Locard in the *Compt. Rend. l'Acad. Sci.*, No. 5, 1898, on the area of distribution of the molluscan fauna of the boreal Atlantic in the deeper waters to the south. Locard pointed out that recent explorations had shown that forms littoral or sublittoral in the boreal regions have spread southward, into ever-deepening waters, from an area approximately of common origin, down the European and African shores to the latitude of Guinea, in about 2000 fathoms, and down the American shores to the latitude of the Antilles, in about 800 fathoms. The area of distribution would thus have the form of a vast triangle of which the apex would rest in about 50 fathoms, somewhere north of Iceland, while the base connected the north-tropical shores of Africa and America, passing upward from east to west from a depth of 2000 fathoms to one of 800. M. Locard's idea, M. Van den Broek thought, was that migration occurs, speaking largely, in opposition to variation. That is, a northern species under pressure from a changing environment or from crowding might spread along the coast where bathymetric and other conditions would be little changed, but the temperature change would be great, or it might spread downward where the changes would be just the opposite. In either case it would follow the line of least resistance; *i.e.*, that in which the required variation would be least. Emigration would replace adaptation and prove a factor of stability.

From this idea M. Van den Broek differs. He points out that while deeper water was doubtless the line of least resistance in migration, and probably called for less variation than migration along the coast would have done (as is indicated, moreover, by the archaic facies of abyssal life), yet the *cause* of migration is uncertain. It may be to escape the competition of more competent rivals, or local enemies, or parasites, or it may be in the wake of a migrating food supply, and in such cases might not be along the line calling for least variation. In the case of the deep-water and arctic Mollusca it

certainly appears that temperature was the main factor, and probably it was true that changes in bathymetric conditions called for less variation than changes of temperature conditions would have done; but, even so, migration proves ultimately a great source of variation. The gradual nature of changes on the sea-bottom leads to very extended distribution, and consequently into areas which are changing in very opposite ways; *e.g.*, sinking and rising. With such wide geographical distribution come extreme differences, eventually, in food and other variation factors. Oscillation of the bottom, M. Van den Broek thinks, would be particularly effective in breaking up the widely dispersed species, and he points out that a species changed by a shoaling of the water would not revert to its old form upon the waters again deepening, but would undergo a second change, removing it yet a step from the ancestral form which lived under similar conditions. M. Van den Broek believes widespread movements like the one under discussion have taken place repeatedly, and that the ancestors of a given fauna are to be looked for, not in the underlying strata, but in distant formations representing the same essentials of environment. Thus he finds the ancestral forms of the Belgian Miocene sands, not in the underlying Oligocene clays, but in the older Miocene of North Germany, while the descendants of the Belgian Miocene sands he identifies, tracing a northeast to southwest migration, accompanied by an increasing salinity and depth, but constant temperature, in the fauna of the Coralline Crag of Suffolk; while above this point, in the Red Crag, he sees the extinction or profound modification of the forms and an invasion of new boreal forms, indicating a great increase of depth by sinking.

This discussion is suggestive, but it seems clear that M. Van den Broek has not settled the question. If his species migrated into deep water because it was the line of least resistance in the first place, why did they not do so again when the bottom rose? Again, is it not true that no matter what the cause of migration may be, that method is chosen because it is the one calling for least modification? We will suppose that a migration along the shore calls for greater modification than migration into deeper water, and that the original habitat is unchanging, but that competition is too great or depredation too fierce. It seems that the greatest amount of modification would be needed before the competition would be successfully met or the depredation resisted. If less were required for this than for the change of habitat, the difficulty would be thus met.

The consideration of migration as a factor of stability is of some

interest, and certainly the deep-sea fauna is an excellent subject for such speculations, because, as Mr. Dall has so interestingly pointed out, the struggle for life on the sea-bottom must in great depths be reduced to a minimum, from the vast area at the disposal of any species, the practically unlimited supply of food, such as it is, the fewness of predatory forms, and the rarity of the sudden vicissitudes of land and littoral life ; so that such modifications as do take place must be comparatively direct results of the physical environment.

F. N. BALCH.

Zoölogical Results of Dr. Willey's Expedition. Part II.[1] — The second part of the zoölogical results of Dr. Willey's expedition to the Western Pacific comprises reports on the genus Millepora by Dr. Sydney J. Hickson, Echinoderms by F. Jeffrey Bell, Holothurians by F. P. Bedford, Sipunculoidæ by A. E. Shipley, Solitary Corals and Postembryonic Development of Cycloseris by J. Stanley Gardiner, Earthworms by F. E. Beddard, and Gorgonacea by Isa L. Hiles.

Dr. Hickson ascribes all of the specimens of Millepora to *M. alicornis*, which, he has before pointed out, is the only species of Millepora so far known. The parts of Dr. Hickson's paper that are particularly interesting are those that are devoted to the parasites of this coral. In addition to worms and algæ, he speaks of "spots scattered over the surface of the coral having the general appearance of a rash." He concludes "that these bodies are clusters or zoögloeæ of parasitic bacteria." Of the thirty-nine species of Echinoderms of Professor Bell's Report, two of which are possibly new, six belong to the Crinoids, twelve to the Echinoids, fourteen to the Asteroids, and seven to the Ophiurioids. Two new species of Holothurians are described by Mr. Bedford among the twenty-four in the collection. Mr. Bedford calls attention to some interesting variations in two species, in the number of stone canals, polian vesicles, and cuverian organs. Mr. Shipley's account of the Sipunculoidea enumerates twenty-three species, none of which are new. Probably the most important contributions to systematic zoölogy in the series are the papers of Mr. Gardiner and Miss Hiles, and Mr. Beddard's report on the earthworms. Mr. Gardiner describes eleven new species of solitary corals among fourteen, and Miss Hiles four new forms of

[1] Willey, Arthur, D.Sc., etc. *Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands, and Elsewhere*, collected during the years 1895, 1896, and 1897. Part II. Cambridge, the University Press (1899), pp. 121–206, Pls. XII–XXIII.

Gorgonacea in ten. Three of the nine earthworms in Mr. Beddard's account are new. The photogravure illustrating Mr. Gardiner's paper is one of the best we have seen in the application of photography to zoölogical illustration.

A striking feature in this second part of the results of Dr. Willey's expedition is, that of the 127 species embraced in the different reports only eighteen are new, and about 90 per cent of these are Anthozoa from comparatively deep water. This is explained by the fact that Dr. Willey was the first to undertake systematic dredging in the Western Pacific. For the high character of the typography and mechanical execution of the book, it is only necessary to say that it bears the imprint of the University Press.

The Distribution of the Perissodactyla, Lamnungia, and Artiodactyla. — Carl Grevé[1] has published a new number of his series of zoögeographical monographs, treating of the distribution of the Perissodactyla (horses, rhinoceroses, tapirs), Lamnungia (Hyrax), and Artiodactyla *non ruminantia* (Hippopotamus, Sus, and their allies). In its general plan this part follows closely the former publications of the same author,[2] and gives a very elaborate report on the distribution of the groups named in the title.

The chief value of this memoir consists in the detailed account of the single localities from which each species has been recorded, and in the summing up of the results for the species, genera, and families in tabular form, accompanied by colored distributional maps for the genera and species. Thus the author has fixed the actual distribution of each species, and his work will always be of much use to any subsequent writer, for it gives the facts of geographical distribution pure and simple.

Evidently the author did not intend to give anything else than facts. However, zoögeography is not satisfied with the mere establishment of facts, but wants explanations; and these identical groups have been the subject of discussion before. We know that in former times, during the Tertiary period, the distribution of every single one of the above groups of mammals was very different from the present, and on the other hand we know that in many cases these old conditions may explain the present ones. Mr. Carl Grevé does not try to enter into any details in this respect; indeed, he gives on the head of each group a general review of our knowledge of its paleontology,

[1] *Abhandl. Kais. Leop.-Carol. Akad. Naturf.*, Bd. lxx, Nr. 5, 1898.

[2] Carnivora and Pinnipedia, *ibid.*, Bd. lxiii, p. 1, and Bd. lxvi, p. 4.

but it would have been much better to leave that aside entirely; for the reader, noticing these discrepancies between recent and fossil forms, is not satisfied with the simple fact that things have changed since Tertiary times; and, farther, these paleontological introductions to each chapter cannot claim at all to be reliable; indeed, they appear to have been written without the slightest knowledge of Tertiary — especially American — Mammalian Paleontology. A. E. O.

Recent Papers on Sipunculids. — In the collections brought from South Africa by Professor M. Weber, Sluiter[1] finds four species and one variety, all known forms of Sipunculids, and one species of Thalassema, making a total of only twelve species and two varieties of these groups reported from the east coast of Africa. He explains the poverty of this fauna as due to the lack of extensive coral reefs, which are its fittest habitat. An appendix to the report deals with the form previously described by Sluiter as *Sipunculus indicus* Peters, which Fischer surmised was not the true *S. indicus.* Sluiter now proposes the name *S. discrepans* for the species, and gives an extended description of the differences between the two. Of especial interest is the dissimilarity in the structure of the skin, which appears to offer one of the readiest means of specific determination in this genus.

In contrast with the poverty of the African coast, Shipley[2] reports a collection made in Rotuma and Funafuti containing fourteen species, of which two, *Sipunculus rotumanus* and *S. funafuti*, are new; one, *Physcosoma varians* Kef., has not yet been reported outside of the Atlantic, where it is common; and one, *Thalassema vegrande* Lamp., has been found but once before, in the Philippines. The other forms noted are common to various localities in the Pacific and Indian Oceans and Red Sea.

The description by the same author of the forms collected by Dr. Willey[3] further shows the richness of this group among the Pacific islands. All the twenty-three species obtained are known forms belonging to Sipunculid genera, as follows: Sipunculus eight species, Physcosoma seven, Aspidosiphon five, and Cloeosiphon, Phascolion, and Phascolosoma one species each; of these, six are identical with species reported in the preceding paper. The author emphasizes

[1] Gephyreen von Süd-Afrika, nebst Bemerkungen über Sipunculus indicus Peters, *Zool. Jahrbücher*, Abt. f. Syst., vol. xi, pp. 442–450, 2 figs.

[2] Report on the Gephyrean Worms collected by Mr. J. Stanley Gardiner at Rotuma and Funafuti, *Proc. Zoöl. Soc.*, London, 1898, pp. 468–473, Pl. XXXVII.

[3] A Report on the Sipunculoidea collected by Dr. Willey at the Loyalty Islands and in New Britain, *Zool. Results*, Pt. ii, pp. 151–160, Pl. XVIII.

the extreme variability of the Sipunculids in external appearance, and the difficulty of specific determination. In *Sipunculus australis* the so-called hooks on the introvert were found to be actually only thickened cuticular ridges, elevated like rolls above the surface; and though characteristic, these structures do not warrant the statement of various authors as to the occasional presence of hooks in this genus. While the large collections of Sipunculids made by Semper, Sluiter, and others, in the Philippine and Malay archipelagoes, have yielded a knowledge of the group in these regions superior to that from other tropical seas, still Shipley is inclined to look upon the Malay archipelago as the center for this group, from which it has spread east along southern Asia to the Red Sea, and outward over the Pacific and Indian Oceans. The abundance, particularly of certain species, in this territory is to be associated with the prevalence of coral reefs over the area. H. B. W.

The Palolo Worm. — The long-existing ignorance concerning this interesting annelid that comes to the surface of the ocean during the third quarter of the moon in October and November, in the Samoan and Fiji islands, has recently been somewhat diminished by the independent researches of Friedländer[1] and of Krämer.[2]

We seem now pretty certain that the creature comes from shallow water — not from mysterious depths; that it lives in dead coral masses; that it casts off the main part of the body to swim free and discharge eggs and sperm when ripe, while the head end probably remains in the coral to regenerate. The suggestion that it is the combined warmth of the sun with least tides that brings on this maturity at a particular phase of the moon seems in the right direction; still we remain ignorant of the real cause of this exact periodicity in reproduction. We are not absolutely sure of the genus to which the creature belongs — despite the fact that so many Europeans have noted its appearance, and that it occurs so abundantly that the natives make its capture for food a set feast, and have incorporated its habits in their folk-lore. E. A. A.

Is Fertilization a Process of Feeding? — N. Iwanzow[3] describes remarkable pseudopodia and tufts of filous threads sent out by *miniature* eggs of a helothurian to seize and engulf spermatozoa. In two

[1] *Biolog. Centralblatt.*, vol. xviii, May, 1898.

[2] *Ibid.*, vol. xix, January, 1899.

[3] *Bul. Soc. Imp. Nat. de Moscou*, Nr. 3, 1897.

hours a large number of sperms are thus slowly ingested, and the egg will take no more till the following day, when a second feeding may occur if sperm is offered; even a third was once accomplished when the eggs were kept alive long enough.

From preserved eggs the author gathers that the ingested sperms pass slowly through the egg *into the nucleus*, and are there resolved into granules distributed along the nuclear network.

The inference is drawn that normal maturation, the formation of polar bodies, by removing nuclear matter, lessens the digestive power of the egg, so that it takes in but one sperm and does not digest it! The chematropism of egg and sperm is but a form of that of animal for food. We are even asked to follow the idea that all psychic processes are but expressions and consequences of nutritional processes. E. A. A.

Zöological Notes. — R. Collett (*Bergens Museums Aarborg* for 1897) gives an interesting account of the present and past distribution and of the habits of the beaver in Norway. A summary in English and numerous photographs of beaver lodges, nests, and young make the results accessible to the general reader. Owing to the protection furnished by the game laws, these animals increased in number from 60 in 1880 to 100 in 1883, and have since held their own, or perhaps gained.

In the last number of the *Archives de Parasitologie*, Blanchard presents a valuable and interesting summary of the cases of pseudo-parasitism in man on the part of various Myriapods. All of the 35 authentic cases, among them 6 entirely new, are reported in full. In 27 cases the animal was located in the nasal fossæ or their connecting cavities, while in 8 cases it came from the alimentary canal. In about half the instances the species was accurately determined.

G. Schwalbe (*Morph. Arbeiten*, Bd. VIII, Heft 2, p. 341, 1898) gives an account of his studies on the supposed open rudimentary marsupial pouches of certain ungulates. His attention was directed to the embryos of the sheep and a species of antelope. He concludes that these pockets, which are quite well developed in sheep embryos, are in no sense homologous with the true marsupium, but that they have a very different origin.

The Graeffe-Saemisch Handbook is announced in a revised edition by Engelmann under the editorship of Professor Saemisch of Bonn. The first part of the new work is to consist of three volumes on the

anatomy and physiology of the eye; the second part, of nine volumes on the pathology and therapeutics of this organ. The large number and high standing of the collaborators give promise of a speedy and satisfactory performance of the work. Volumes, or parts of volumes, will be sold separately.

The rich collection of cetacean embryos made some years ago by Professor Kükenthal is being put to good use, as shown by the last number of *Jenaische Zeitschrift* (Bd. XXXII, Heft 1 and 2), which is made up of the following articles based on a study of this material: F. Jungklaus, The Stomach of the Cetaceans; O. Müller, Researches on the Alterations which the Mammalian Respiratory Organs have undergone in Adaptation to Water Life; W. Daudt, Contributions to our Knowledge of the Urogenital Apparatus of the Cetaceans.

In the *Festschrift til Kong Oskar II*, Dr. Guldberg publishes the results of his investigation on the asymmetry of the higher vertebrates. Osteometric statistics, as well as data from the weight of the musculature of opposite sides of the body, indicate the occurrence of a morphological asymmetry in birds, in many mammals, and in man. This asymmetry is least at birth and increases with age; it finds its physiological expression in the tendency to move in a circle. Compensated and crossed asymmetry are of frequent occurrence.

The Organs of Respiration of the Oniscidæ are described by Professor J. H. Stoller in *Zoologica*. He finds the gills to be homologous with those of aquatic isopods, but adapted to breathing atmospheric air. A respiratory tree, resembling the tracheæ of insects, is bathed by the blood which is brought to the gills. Adaptations for the prevention of the desiccation of the blood are found, and there is no mechanism for forcible inspiration and expiration of the air.

The Parasites of the Flamingo have recently been studied in Tunis by Dr. M. Lühe (*Situngsb. Pr. Akad. Wiss.*, Vol. XL, pp. 619–628), who has found *Tænia lamelligera* Owen, which Diamare made the type of a new genus, Amabilia. Three species of Drepanodotænia were also found: *Tænia liguloides* Gerv., and its immature form, which proved to be identical with *T. Caroli* Par., and *T. megalorchis* and *T. ischnorhynchan.* sp. In the same host *Monostoma attenuatum* Rud. was present in the cæcum, and the new species *Distomum michropharyngeum* in the gall bladder, and *Echinostomum thœnicopteri* in the small intestine. From the civet-cat two new forms of Dipylidium, *D. triseriale* and *D. monoophorum*, were secured.

The specimens of Mermis in the Kgl. Museum für Naturkunde in Berlin have recently been studied by von Linstow (*Arch. mikr. Anat.*, Vol. LIII, pp. 149–168), who gives an extended taxonomic account of the genus, followed by a discussion of anatomical and histological features. In the last three lines of the paper and all too easily overlooked comes the establishment of a new genus for those species, *M. crassa* and *M. aquatilis*, which are characterized by the possession of only a single spicule.

Dr. Saint-Remy has added a complement to his valuable synopsis of the monogenetic Trematods (*Arch. Parasitol.*, Vol. I, No. 4, pp. 521–571). The present paper is a revision of the synopsis, including all new matter since 1891, and is a most welcome contribution to our knowledge of this important group of parasitic worms. Forty-nine species have been added and a new key prepared.

Indo-Malayan Landplanarians are brought together in a synoptical table or key for easy determination by von Graff (*Ann. Jardin Bot. Buitenzorg*, Supp. II, pp. 113–127). About 35 per cent of all known species are found in this region.

Dr. N. A. Cobb has added another to his series of studies on the free-living Nematoda (*Proc. Linn. Soc. N. S. W.*, Vol. XXIII, No. 91, pp. 383–407), adding seventeen new species to the worm fauna of Australia. All of the forms are from Port Jackson.

The Leeches of the U. S. National Museum have been studied by J. Percy Moore (*Proc. U. S. Nat. Mus.*, Vol. XXI, pp. 545–563), and of the small national collection, consisting of species from all parts, six are described as new.

Hypodermic Impregnation has been observed by Dr. E. G. Gardiner in the acoelous turbellarian *Polychœrus caudatus* (*Journ. Morph.*, Vol. XV, No. 1), thus adding another to the list of forms in which impregnation of this sort occurs.

The Earthworms of Japan are being studied by S. Goto and S. Hatai, the first of a series of papers being devoted to seventeen species of Perichæta (*Annot. Zool. Japon.*, Vol. II, No. 3).

Dr. R. S. Bergh in *Fauna Chilensis* reports upon the opisthobranchiate mollusca collected by Dr. Plate on the western coast of South America. A number of forms described fifty years ago by D'Orbigny from this locality are again brought to light, together with twelve new species.

Poisonous serpents are said not to exist in New Caledonia, contrary to the statement of Hoffmann in Bronn's *Thierreich*. Dr. Trouessart (*Bull. Soc. Zool. France*, Vol. XXIII, No. 11) believes that *Neelaps caledonicus* was derived by Hoffmann by misreading Günther's *Neelaps calonatus* from New Grenada.

The Zoantharia of the Magellanic Region have been reported on by Dr. O. Carlgren, and published by Friederichsen & Co. of Hamburg under the general title of *Hamburger Magelhaensische Sammelreise*. Thirteen new species and three new genera are described.

A new enemy to the grasshoppers, which for several years have been devasting Argentina, has developed in the shape of a scarabrid beetle belonging to the genus Frox, which has taken to eating the eggs.

Albinism in a squirrel is illustrated by photographs in *Bull. Soc. Zool. France*, Vol. XXIII, No. 11, by L. Petit, in the case of a brown squirrel which is about 50 per cent albino and nearly evenly marked.

Mr. W. S. Calman has published an exhaustive review of the literature on the reproduction of the Rotifera in *Natural Science*.

BOTANY.

Vines's Text-Book.[1] — In scope and bulk intermediate between Professor Vines's *Students' Text-Book of Botany* and the English edition of Prantl's *Elementary Text-Book*, this volume treats of the morphology, anatomy, physiology, and classification of plants in a clear and understandable way, and the illustrations, many of which are familiar to users of text-books, are in the main well selected.

T.

The Teacher's Leaflets, chiefly on nature-study, issued by the Agricultural Experiment Station of Cornell University, are admirably plain and direct presentations of everyday phenomena, the understanding of which is obscured by many of the more learned treatises. How a squash plant gets out of the seed, How a candle burns, Four apple twigs, How the trees look in winter, A children's garden, Some tent-makers, What is nature-study? Hint on making collec-

[1] Vines, S. H. *An Elementary Text-Book of Botany*. London, Swan Sonnenschein & Co. New York, The Macmillan Company. 611 pp., 397 ff. Price $2.25.

tions of insects, The leaves and acorns of our common oaks, The life history of the toad (with a unique tail-piece), and The birds and I, are the titles of some of the leaflets. T.

Elementary Science Bulletins of the Michigan Experiment Station, of which six have thus far been issued, dealing with Beans and peas before and after sprouting, Wheat and buckwheat before and after sprouting, Timothy and red clover before and after sprouting, Leaves of clovers at different times of day, Branches of sugar maple and beech as seen in winter, and Potatoes, rutabagas, and onions, are comparable with the *Teacher's Leaflets* of the Cornell Station. All of the series yet issued are by Professor Beal. T.

Water-Lenticels. — In a recent number of the *Forstlich Naturwissenschaftliche Zeitschrift*, Tubeuf discusses the formation of water-lenticels and their significance. After a brief statement of some previous views as to the occurrence and function of ærenchyma tissue, he puts the following questions:

1. Is the development of water-lenticels due to the irritant influence of the liquid water surrounding the stem, and is their development above the water due to a transmitted stimulus?

2. Is their development due to lack of oxygen?

3. Is their development an ecological adaptation of woody plants living in moist localities, or is their occurrence a general one?

He concludes that their occurrence is not a peculiarity of plants in moist soils, but is a general attribute of woody stems. Furthermore, the lenticels formed whenever there was moisture; in other words, *liquid* water was not necessary, hence there is no such thing as transmitted stimulus.

He comes to no definite conclusion as to the relation between lack of oxygen and profuse formation of water-lenticels, but is inclined to regard the water as the potent factor. A number of figures accompany the paper, showing water-lenticels of Sambucus, Ulmus, and Caragana. It may be mentioned that water-lenticels and ærenchyma on branches of Sambucus and other woody plants were described and figured by von Schrenk in *Trans. Am. Micr. Soc.*, Vol. VII (1896), p. 98, Pls. I–III. T.

Root-Tubercles of Alder. — The tubercles found on the roots of the alder and genera of the Eleagnaceæ were attributed by their discoverer, Woronin, to a fungus which he called *Schinzia alni*, and which

Brunchorst recently renamed *Frankia subtilis*. Frank regarded the peculiar cells always found in these tubercles as bodies of fungus origin, which had degenerated because of their mode of life within the cells of another plant. Moeller, on the other hand, regarded them as single-celled Hyphomycetes. From an extended series of experiments Hiltner[1] comes to the conclusion that *Frankia subtilis* is not a single-celled Hyphomycete, but a bacterial organism which possesses sporangia, and because of these and other peculiarities forms a connecting link between the bacteria and the true fungi. He succeeded in inoculating the organisms into roots of alder seedlings grown in N.-free nutritive solutions. The organisms enter through the root hairs in a manner similar to that of the organism causing leguminous tubercles. Inside of each hair is a mucilaginous thread in which the bacteria lie imbedded without any system or regularity. Before reaching the root proper the mucilaginous mass becomes filamentous and resembles mycelial threads. Within the root the mucilage masses resemble plasmodia, which extend from cell to cell, and ultimately become of a spongy consistency because of the appearance of numerous vacuoles, surrounded by thin walls of mucilage, in which the bacteria, now more or less in thread form, lie. Very soon after the formation of a tubercle the individual bacteria change into spheres filled with albumen, which rapidly differentiates into spores; in other words, the spheres represent sporangia. The spores germinate rapidly, forming short rods which fill the cells of the tubercle but develop no mucilage. Hiltner points out that, with the exception of *Bacillus erythrosporus*, few bacteria form sporangia. According to his view, the bacteroids of the leguminous tubercles must be regarded as sporangia, and in that case the bacteria of the alder and Leguminosæ, both forming plasmodia, constitute a new group of bacteria.

Numerous experiments have proven the fact that the organisms in the alder tubercles are capable of fixing atmospheric nitrogen; and, unlike those of the Leguminosæ, they are able to function fully under water. We are promised a full exposition of the subject in another journal at no distant date.

Hermann von Schrenk.

The Red and Blue Coloring Matters of Flowers are discussed in *Natural Science* for February, by P. Q. Keegan, in continuation of a paper published in the same journal of December last. In view of

[1] Hiltner, L. On the Origin and Physiological Significance of Root-Tubercles. *B.* The Root-Tubercles of the Alders and Eleagnaceæ, *Forstlich Naturwissensch. Zeitschr.*, Bd. vii, p. 415, 1898.

the recent report of a blue carnation and the long horticultural search for a blue rose, it may be of interest to quote Dr. Keegan's conclusions: "1. A blue flower is unproducible in species which contain or are capable of forming phlobaphenic tannin [*i.e.*, chromogen, which on advanced oxidation evolves brown-red or muddy anhydrides more than sufficient to neutralize and overcome any tendency to blue coloration incident to the presence of gallic acid], no matter what the development of the inflorescence may amount to. 2. A blue flower is more likely to be produced in a species having a gamopetalous corolla or perianth, and therefore liable to evolve by higher oxidation a certain quantity of a high oxybenzoic acid. 3. In species wherein the tannin natural to the organism is iron-greening and non-phlobaphenic, a blue flower may possibly be producible in a polypetalous corolla, provided always that the petals or perianth be large relatively to the height of the plant and to the size and robustness of its stem and leaves; in this case it is uncertain whether gallic acid is necessary for the production of the effect, but any way an alkaline compound of an oxybenzoic acid would seem to be indispensable."

Botanical Notes.—Captain J. Donnell Smith, whose work on Central American botany is well and favorably known, publishes an enumeration of the plants collected in Central America by Dr. W. C. Shannon, as an appendix to Vol. I, Part II, of the report of surveys and explorations made from 1891 to 1893 by the Intercontinental Railway Commission. The "separates" of the article bear the imprint Washington, 1898.

Professor Peck's report of the state botanist, reprinted from the 51st annual report of the New York state museum, as is usual with his reports, contains descriptions and figures of a considerable number of fungi, several of which are believed to be new to science. It is unfortunate that, while the text is in octavo, the plates are of quarto size and separately bound.

At Bologna is preserved, in book form, the herbarium of Aldrovandi, dating from the middle of the sixteenth century. In *Malpighia*, Vol. XII, Fasc. 7–10, Professor Mattirolo, now of Florence, but until recently stationed at the University of Bologna, gives an annotated catalogue of the plants represented in the first volume of this herbarium, his list reaching 557 numbers.

Acalypha hispida, a New Guinea plant which, under the name of *A. sanderi*, is attracting a good deal of attention in horticultural

circles, is well figured in the *Botanical Magazine* for January. Sir Joseph Hooker calls attention to the fact that it was figured by Rumphius as early as 1690.

A portrait of *George Bentham*, accompanied by a biographical memoir by Sir Joseph Hooker, his collaborator on the great "Genera Plantarum," appears in the concluding number of Vol. XII of the *Annals of Botany.*

Professor Sargent contributes to the *Botanical Gazette* for February an article on new or little-known North American trees, in which the Thrinax-like palms of Florida are revised, — the new genus Coccothrinax being proposed, — and a new elm related to *Ulmus racemosa* is described under the name *U. serotina.*

Recent issues of the *Deutsche Botanische Monatsschrift* contain a series of articles, by W. N. Suksdorf, entitled "Washingtonische Pflanzen," and descriptive of a considerable number of species and varieties from our northwest coast, which are believed to be as yet undescribed or unnamed.

A notion of the extent to which scientific as well as military and commercial activity is penetrating Africa may be obtained from an examination of the issue of the *Botanische Jahrbücher* of January 31, the greater part of which is devoted to a continuation of the "Beiträge zur Flora von Afrika," by Dr. Engler and his associates.

Vanilla culture, as practiced in the Seychelles, is described by S. J. Galbraith in *Bulletin No. 21* of the United States Department of Agriculture, Division of Botany.

The acaulescent blue violets of the vicinity of Ottawa are described and figured by James M. Macoun in *The Ottawa Naturalist* for January.

Bulletin No. 48 of the Texas Agricultural Experiment Station, which is devoted to grapes, contains a half-tone reproduction of a photograph by Professor Munson, showing the seeds of North American grapes.

Plants yielding Myrrh and Bdellium are monographically treated in January numbers of the *Pharmaceutical Journal* by E. M. Holmes, of the Museum of the Pharmaceutical Society of Great Britain.

Robert Smith contributes a short article "on the study of plant associations" to *Natural Science* for February, illustrating his remarks

by an analysis of the flora of the Ayrshire coast between Prestwick and Troon.

"Catalogue of herbarium specimens for exchange," a rather unusual title for a bulletin of an agricultural experiment station, is the title of *Bulletin No. 51* of the North Carolina station, issued under date of December 16 last.

Silphium lanceolatum is the name proposed by Mr. Canby in the February number of the *Botanical Gazette* for a new species of the South Atlantic region.

The comparative morphology of cactus embryos and seedlings is considered by Professor Ganong in the *Annals of Botany* for December.

Professor Rowlee describes and figures two Mexican willows — one new — in the *Botanical Gazette* for February.

Meconopsis heterophylla, of California, is figured in the January number of the *Botanical Magazine.*

Stachys arvensis, in Australia, is said to cause fatal cases of poisoning when eaten by bullocks and horses. — *Queensland Agr. Journ.*, January.

Lewisia tweedyi, of Washington, is figured in the *Botanical Magazine* for January.

NEWS.

A RECENT fire in Geneva destroyed the herbarium of Professor Chodat, of the university.

A French Association des Anatomistes has recently been formed, holding its first meeting in Paris, January 5 and 6. The secretary is Professor A. Nicholas, of Nancy.

The United States Fish Commission will have $19,200 for scientific investigation during the present year.

The eighth session of the International Geological Congress will be held in Paris, August 16–28, 1900. Circulars regarding the proposed excursions will be issued this year.

The Gray herbarium, of Harvard University, has recently purchased the collection of Compositæ of the late Dr. F. W. Klatt, of Hamburg. It contains about 11,000 specimens, and will probably add 60 genera and 1500 species to the Gray herbarium. The Gray herbarium previously contained about 35,000 sheets of composites.

The following state legislation in 1898 is of interest to naturalists. New Jersey provides for a state entomologist; Louisiana has passed a bill providing for the establishment of a biological station in the Gulf of Mexico, to coöperate with the United States Fish Commission for the investigation of problems affecting the fisheries of the state; New York forbids the killing at any time of wild moose, elk, caribou, and antelope; Ohio has repealed the law relative to the trapping or killing of muskrats, mink, and otter.

The Saxon government is to erect a new museum building at Dresden, and the director of the museum, Dr. A. B. Meyer, with the architect, Professor Wallot, will visit the United States this autumn for the purpose of studying the museum buildings of this country.

For some years there has been a growing feeling in England that the northern coal fields will give out, and that endeavors should be made to find coal in other parts of the island. To ascertain whether other workable beds occurred in other regions, a boring has been made at Brabourne, in Kent, which has now reached a depth of 2000 feet, and is now in lower carboniferous rocks.

An English committee has been formed to conduct the study of the region around Lake Tanganyika, in Central Africa. It is hoped that they will be able to study especially the aquatic fauna and flora of the region, as well as its geology. An appeal is now made for funds to carry out the plans, it being estimated that about $25,000 will be needed for the purpose.

The *American Journal of Physiology* has adopted a plan, advocated for some years by Dr. Bowditch, of publishing with each number titles of the various articles on thin paper, which can be cut out and pasted on index cards. Each title is accompanied by a brief abstract of the matter recorded in the article.

At the annual election of the California Academy of Sciences, held January 3, the following officers were elected: President, William E. Ritter; 1st Vice-President, Charles H. Gilbert; 2d Vice-President, H. H. Behr; Corresponding Secretary, J. O'B. Gunn; Recording Secretary, G. P. Rixford; Treasurer, L. H. Foote; Librarian, Louis Falkenau; Director of the Museum, Charles A. Keeler; Trustees, William M. Pierson, William H. Crocker, James F. Houghton, C. E. Grunsky, George C. Perkins, George W. Dickie, E. J. Molera. The yearly report of the president, William E. Ritter, shows the past year to have been one of earnest activity in the various departments. The necessity is urged of concentrating both the efforts and the funds of the academy toward making complete the natural history collections of the state. Especial stress is laid upon the desirability of exploring the waters of the Pacific that wash the California coast. A gift of $1000 from C. P. Huntington for the publication fund was announced.

The Academy of Sciences of Vienna has sent an expedition to South Arabia under the leadership of Count Lundberg. Professor Oskar Simony accompanies the expedition as botanist and physicist; Dr. Cossmat, geologist; and Dr. Gimley, as physician and botanist.

Trinity College, at Hartford, Conn., is to have a Natural History Hall, erected at a cost of $40,000. The collections and laboratories are at present in cramped quarters in the basement of the main building of the college.

Dr. Ulric Dahlgren has been appointed as assistant director of the Marine Biological Laboratory at Woods Holl, as successor to the late Professor Peck.

Mr. J. G. Baker has resigned his position as director of the Kew Botanical Herbarium.

The British government has established a botanical garden and experiment station at Uganda, Central Africa, under the directorship of Alexander Whyte.

Dr. J. Gaule, professor of physiology in the University of Zürich, has resigned his position.

At a recent meeting of the Board of Management of the Marine Biological Laboratory of Canada it was resolved to proceed at once with the construction of a floating station, to be ready for occupation early in June, and for the coming summer it will be located at St. Andrews. The Board was enlarged by the addition of Dr. A. B. MacCallum, of Toronto University. The executive officers are Professor E. E. Prince, Director, and Professor D. P. Penhallow, Secretary-Treasurer.

The University of Cambridge has awarded the Walsingham medal to J. Graham Kerr for his paper on the life history of Lepidosiren.

Dr. O. Seydel, for some years lektor in anatomy in the University of Amsterdam, and well known for his researches on the organ of Jacobson, has resigned and has returned to Germany.

The litigation over the Nobel bequest has come to an end, and there is now about $7,000,000 available for prizes. There will be five of these to be awarded annually, with a value of about $40,000 each.

The University of Aberdeen has under consideration the formation of loan collections of natural history to be suitable for instruction in schools. These are to be loaned to teachers, who will use them in their classes and be responsible for their safe return. Similar collections would be of great value in certain regions of the United States, and if we remember aright the University of Illinois at one time had a similar plan under consideration, if not in actual operation.

Appointments: Dr. Angelo Andres, formerly professor of general and agricultural zoölogy in the higher agricultural school at Milan, has been called to the chair of zoölogy in the University of Parma. — R. T. Baker, curator of the Technological Museum at Sydney, New South Wales. — Elmer D. Ball, assistant entomologist in the Colorado Experiment Station. — Dr. F. J. Becker, of Prag, professor of mineralogy in the University of Vienna. — Dr. J. Behrens, bacteriologist at Berlin. — Dr. P. Berggren, professor of botany in the Uni-

versity of Lund, Sweden.—Dr. L. Böhmig, professor extraordinarius of zoölogy in the University of Graz.—Karl Brischke, director of the botanical garden at Thorn.—Dr. Capitan, professor of prehistoric anthropology at Paris.—Dr. Friedrich Dahl, assistant in the zoölogical museum in Berlin.—Dr. Dannenberg, of Aachen, professor of mineralogy and geology in the mining school at Clausthal, Germany.—Dr. Rudolf Disselhorst, professor of animal physiology in the University of Halle.—Dr. Max von Frey, professor of physiology in the University of Zürich.—Dr. Thaddeus von Garbowski, of Vienna, privat docent for zoölogy in the University of Cracow.—M. Gravier, assistant in the Museum of Natural History at Paris.—Dr. E. Hallier, of Munich, assistant in the Botanical Museum at Hamburg.—Dr. Hans Held, professor extraordinarius of anatomy in the University of Leipzig.—Mr. W. B. Hemsley, curator of the Kew Herbarium.—Dr. Hettner, of Tübingen, professor of geography in the University of Würzburg.—Dr. Casimir Kwietnewski, assistant in the museum of zoölogy and comparative anatomy of the University of Messina.—Alberto Löfgren, director of the botanical gardens at São Paulo, Brazil.—Professor D. T. MacDougal, of the University of Minnesota, director of the laboratories in the New York Botanical Garden.—Dr. A. Manrizio, assistant in botany in the Agricultural School in Berlin.—Dr. Ernst Mehnert, of Strassburg, privat docent for anatomy in the University of Halle.—A. S. Miller, geologist to the Idaho Experiment Station.—Dr. Alois Mrazek, privat docent for zoölogy in the Bohemian University at Prag.—Dr. Adolf Osterwalder, assistant in the vegetable physiological laboratory of the Agricultural Station at Wädensweil, Switzerland.—Dr. Pelikan, professor extraordinarius of mineralogy in the German University at Prag.—Dr. Hans Rebel, privat docent for zoölogy in the Vienna Agricultural School.—Dr. Bernard Schmid, privat docent for botany in the University of Tübingen.—Dr. L. S. Schultze, assistant in the zoölogical institute of the University of Jena.—Professor D'Arcy W. Thompson, of Dundee, member of the Fishery Board for Scotland.—Alexandro Trotter, assistant in the Padua Botanical Gardens.—Dr. Carl Freiherr von Tubeuf, director of the botanical laboratory in the Berlin Experiment Station.—Dr. Karl Wehmer, privat docent for mycology in the Hannover Technical School, titular professor.—Dr. Franz Werner, privat docent for zoölogy in the University of Vienna.—Dr. N. Wille, curator of the museum and herbarium of the University of Christiania.—Dr. A. Zalevski, privat docent for botany in the University of Lemberg.

Deaths: W. G. Atherstone, student of South African geology. — Charles E. Beddome, conchologist, at Hobartstown, Tasmania, September 1. — Dr. Sven Borgström, student of mosses, at Stockholm, May 13, 1898, aged 72. — Karl Fried. Wilh. Claus, professor of zoölogy at the University of Vienna, January 18, aged 63. — William Colchester, a collector of fossils, at Cambridge, England, in December, at an advanced age. — Achille Costa, professor of zoölogy in the University of Naples, in November. — Dr. Gottlieb Gluge, formerly professor of anatomy and physiology in the University of Brussels, aged 86. — Mr. Gilbert H. Hicks, first assistant botanist in the Department of Agriculture, Dec. 7, 1898. — Rev. Thomas Hincks, at Clifton, England, January 26. He was the author of valuable manuals of the British Hydroids and Polyzoa. — Professor Paul Kramer, the student of Acari, in Magdeburg, in November. — Dr. Hans C. Müller, ornithologist, at Thorshavn, Faroe Island, Dec. 24, 1897, aged 70. — Dr. Hermann Müller, privat docent for bacteriology in the University of Vienna, aged 32. — Dr. Karl Müller, the well-known bryologist of Halle, and editor of *Die Natur*, February 9, at the age of 80 years. — Paul Iérémééiew, professor at the Institute of Mines, St. Petersburg, and member of the Imperial Academy. — Wilbur Wilson Thoburn, professor of bio-mechanics in the Leland Stanford University. — Emerich Vellay, the Hungarian entomologist, August 6. — Dr. Constantin Vousakis, professor of physiology in the University of Athens. — Anton W. Wiebke, ornithologist, of Hamburg. — Dr. G. Wolffhügel, professor of hygiene in the University of Göttingen.

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(The regular exchanges of the *American Naturalist* are not included.)

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IN THEIR WIDEST SENSE

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THE

AMERICAN NATURALIST

Vol. XXXIII. *June, 1899.* No. 390.

THE EFFICIENCY OF SOME PROTECTIVE ADAPTATIONS IN SECURING INSECTS FROM BIRDS.

SYLVESTER D. JUDD.

During the past four years I have been studying the food habits of birds in the *Biological Survey* of the U. S. Department of Agriculture. Owing to the extreme kindness of my chief, Dr. C. Hart Merriam, I have now at my disposal data accumulated from the examination of the stomach contents of fifteen thousand birds. My colleague, Professor F. E. L. Beal, has given me invaluable assistance in the preparation of this paper. I am also indebted for criticism to Drs. L. O. Howard and Chas. Wardell Stiles. Messrs. Schwarz, Banks, Chittenden, and Pratt, of the Department of Agriculture, have been most kind in identifying insects.

The bulk of the insect food of birds consists of grasshoppers (Acrididæ and Locustidæ), noctuid larvæ, weevils, smaller carabids, May beetles and their allies, smaller dung beetles (Onthophagus, Hister, Atænius, and Aphodius), chrysomelids, true bugs (Heteroptera), parasitic Hymenoptera (mostly Ichneumonidæ), ants, and spiders.[1]

[1] Included thus for convenience.

Protective devices of insects do not always baffle birds, and to illustrate this I have arranged my results in the following manner:

A. Restricted Protective Coloration (Resemblance to Substratum).

I. Orthoptera.

1. Grasshoppers (Locustidæ and Acrididæ), 300 species of birds.
2. Katydids (Locustidæ), brown thrasher, chippy, screech owl, great horned owl, Mississippi kite, red-shouldered hawk.
3. Walking Sticks (Diapheromera), crow blackbird, two species of cuckoos.

II. Lepidoptera.

1. Measuring Worms (Geometridæ), catbird, house wren, two species of cuckoos, scarlet tanager, red-winged blackbird, cowbird, bobolink, Baltimore oriole, purple finch, indigo bird, Wilson's thrush, cedar bird, white-winged crossbill, chippy, kingbird, and other flycatchers, vireos, Carolina titmouse, and many warblers.
2. Ground-colored Cutworms (Noctuidæ), practically all insectivorous birds which feed upon the ground to any extent.
3. Longitudinally striped Caterpillars:
   (*a*) Army worm, red-headed woodpecker, flicker, and other woodpeckers, cowbird, most blackbirds, orioles, meadow lark, bobolink, English sparrow, many native sparrows, kingbird, phœbe, quail, robin, bluebird.
4. Green Caterpillars:
   (*a*) Sphinxes, catbird, blue jay, two cuckoos, white-eyed vireo, red-shouldered hawk, broad-winged hawk.
   (*b*) Ailanthus Worm, yellow-throated vireo.
   (*c*) Cabbage Worm (Pieris), chippy, robin.
   (*d*) *Telea polyphemus*, broad-winged hawk.
5. Small protectively colored moths, several species of sparrows.

III. Coleoptera.

1. Protectively colored Longicorns (Cerambycidæ), many woodpeckers.
   (*a*) Monohammus, great-crested flycatcher.
2. Weevils, all insectivorous birds.
3. Chlamys (Chrysomelidæ), robin, bluebird, native sparrows.

IV. Hemiptera.

1. Jassidæ, marsh wren, house wren, cowbird, blackbirds, great-crested flycatcher, kingbird.
2. Membracidæ, great-crested flycatcher, Brewer's blackbird.

3. Scale Insects (Coccidæ), cedar bird, woodpeckers, white-breasted nuthatch, chickadee, California bush tit.
4. *Nezara hilaris*, or Brochymena, Podisus, or Euschistus, catbird, brown thrasher, house wren, cardinal, cuckoos, blackbirds, kingbird, phœbe, great-crested flycatcher, vireos, hermit thrush, blue jay, robin, Acadian flycatcher, least flycatcher, crow, cowbird, white-bellied swallow.
5. Flat Bugs (Aradidæ), downy woodpecker.
6. *Piesma cinerea*, chickadee, white-breasted nuthatch.
7. Thread-legged Bugs (Emesidæ), golden-cheeked warbler.

V. Diptera (Crane Flies [Tipulidæ]), many insectivorous birds.

VI. Trichoptera (Larval Caddice Flies), red-winged blackbird.

VII. Arachnida.

1. Spiders (Araneida), general resemblance to substratum, practically all land birds.
2. Harvest Spiders (Phalangidæ), many birds, especially catbird, wrens, and cuckoos.

B. Special Devices — Hairs.

I. Lepidoptera (Larvæ).

1. Arctiids, robin, bluebird, catbird, sparrow hawk, cuckoos, and shrikes.
2. Gypsy Moth, blue jay, robin, chickadee, chippy, vireos, cuckoos, Baltimore oriole.
3. *Vanessa antiopa*, Baltimore oriole, cuckoos.

C. Special Devices — Stings or Poisonous Bites.

I. Hymenoptera.

1. Bombus, or Xylocopa, bluebird, blue jay, olive-sided flycatcher, great-crested flycatcher.
2. Honey-bee (*Apis mellifica*), wood pewee, phœbe, olive-sided flycatcher, kingbird.
3. Andrena, or Halictus, red-eyed vireo, least flycatcher, great-crested flycatcher, wood pewee, olive-sided flycatcher, kingbird, blue jay, swift, cliff swallow, white-bellied swallow, humming bird, chestnut-sided warbler, Maryland yellowthroat, blue jay.
4. Scoliids (especially Tiphia, Myzine, and Elis), English sparrow, least flycatcher, kingbird, wood pewee, cliff swallow, rough-winged swallow, barn swallow.
5. Vespa, or Polistes, red-bellied woodpecker, kingbird, yellow-bellied flycatcher.
6. Mutillidæ, Says's phœbe, western wood pewee.

II. Arachnida.

1. Large Biting Spiders, many birds.
2. Scorpion, screech owl, great-horned owl, burrowing owl.

III. Myriopoda.

1. Lithobius and others, many birds.

D. Special Devices — Ill-Flavored, or Scented, or with Irritating Qualities.

I. Hymenoptera.

1. Ants, most land birds.

II. Hemiptera.

1. Heteroptera, all insectivorous birds.
   (*a*) Anasa, broad-winged hawk, red-shouldered hawk.
   (*b*) *Prionidus cristatus*, crow.
   (*c*) Pentatomidæ, majority of insectivorous birds.
   (*d*) Hygrotrechus, song sparrow.

III. Coleoptera.

1. Carabidæ:
   (*a*) Smaller Carabidæ, such as Amara, Anisodactylus, Agonoderus, Pterostichus, Cratacanthus, Bembidium, and smaller Harpalus, all insectivorous birds.
   (*b*) *Harpalus caliginosus*, or *pennsylvanicus*, crow, blackbirds, meadow lark, catbird, brown thrasher, robin, kingbird, Cassin's kingbird, dickcissel.
   (*c*) Carabus, bluebird and crow, crow blackbird.
   (*d*) Cychrus, crow blackbird.
   (*e*) *Galerita janus*, bluebird, blue jay, young crow blackbirds.
   (*f*) Chlænius, crow, crow blackbird, catbird, bluebird.
   (*g*) *Calosoma scrutator*, or *calidum*, crow, crow blackbird, red-headed woodpecker, blue jay, cuckoo.
2. Histeridæ and Scarabæidæ Laparosticti (Aphodius, Atænius Onthophagus, Canthon) (foul from food), most insectivorous birds.
3. Silphidæ (Silpha or Necrophorus), crow, loggerhead shrike, kingbird.
4. Some Tenebrionidæ:
   (*a*) Nyctobates, catbird.
5. Coccinellidæ, flycatcher, red-eyed vireo, song sparrow, marsh wren, Lewis's woodpecker.
6. Chrysomelidæ:
   (*a*) Potato Beetle (*Doryphora 10-lineata*), wood thrush, rose-breasted grosbeak, quail, crow, cuckoo, catbird.

(*b*) *Diabrotica 12-punctata*, Attwater's grouse, blue jay, catbird, red-eyed vireo, cliff swallow, brown thrasher, purple martin, phœbe, yellow-bellied flycatcher.

(*c*) *Galerucella luteola*, phœbe, cedar bird.

7. Lampyridæ (Chauliognathus), see warning coloration.

IV. Neuroptera.

1. Chrysopa, great-crested flycatcher, song sparrow.

V. Arachnida.

1. Harvest Spiders (Phalangidæ), many birds.

VI. Myriopoda.

1. Millipedes, many birds.

E. Warning Coloration.

I. Lepidoptera.

1. Orgyia, larval, two species of cuckoos.
2. *Datana ministra* larval, two species of cuckoos.
3. *Anisota senatoria* larval, two species of cuckoos and robin.
4. Isabella caterpillar, loggerhead shrike, robin, sparrow hawk.
5. Showy butterflies, catbird, kingbird, wood pewee, purple martin, scarlet tanager, crow blackbird, cuckoo, English sparrow, song sparrow.

II. Hymenoptera.

1. Agapostemon and other metallic green small bees, flycatchers, humming bird, and a dozen other species.
2. Chrysis, many birds.
3. *Vespa maculata*, yellow-bellied flycatcher.
4. *Vespa germanica*, kingbird.
5. Elis and Myzine, see under stinging insects.
6. *Tremex columba*, blue jay, olive-sided flycatcher, loggerhead shrike, red-eyed vireo, night hawk.

III. Coleoptera.

1. Carabidæ :

(*a*) Calosoma, Chlænius, Pterostichus, see under irritating fluids.

(*b*) *Lebia grandis*, kingbird.

2. Lampyridæ :

(*a*) Chauliognathus, kingbird, wood pewee, phœbe, cliff swallow, catbird.

3. Scarabæidæ :

(*a*) *Allorhina nitida*, blackbirds, crow, catbird, blue jay, red-headed woodpecker.

(*b*) *Euphoria fulgida*, blackbirds, crow, blue jay, kingbird.

(*c*) Godsmith Beetle (*Cotalpa lanigera*), blue jay, yellow-billed cuckoo, purple martin.

(*d*) *Pelidnota punctata*, blue jay.

(*e*) *Phanæus carnifex*, blackbirds, crow, catbird, brown thrasher, great-crested flycatcher.

(*f*) *Bolbocerus farctus*, kingbird, catbird.

4. Chrysomelidæ:

(*a*) *Systena tæniata*, song sparrow, chippy, yellow-winged sparrow, field sparrow, Maryland yellowthroat.

(*b*) *Odontota dorsalis*, catbird, great-crested flycatcher, robin, orchard oriole, Baltimore oriole, Carolina wren, song sparrow, chippy, chewink, cardinal, cedar bird, yellow warbler, wood pewee.

(*c*) Small metallic green beetles (especially Chætocnema, Crepidodera, Dibolia, Donacia, Graphops), a great many birds.

(*d*) Doryphora, Diabrotica, see ill-flavored insects.

(*e*) *Chrysomela pulchra*, kingbird.

(*f*) *Lema trilineata*, phœbe, least flycatcher, Acadian flycatcher.

(*g*) *Lina scripta*, cuckoo.

(*h*) *Crioceris asparagi*, kingbird.

(*i*) *Gastroidea polygoni*, crow blackbird, catbird.

(*j*) *Coptocycla signifera*, crow blackbird.

5. Cerambycidae:

(*a*) Anthophylax, kingbird.

(*b*) *Neoclytus caprea*, catbird.

6. Malachiidæ (*Collops quadrimaculatus*), phœbe.

7. Nitidulidæ (*Ips fasciatus*), white-bellied swallow.

8. Buprestidæ (metallic colored), red-bellied woodpecker, great-crested fly-catcher, black-billed cuckoo, cardinal.

9. Cucujidæ (*Cucujus cavipes*), great-crested flycatcher.

10. Coccinelidæ, see under ill-flavored insects.

11. Silphidæ (Necrophorus), see under ill-flavored insects.

12. Byrrhidæ, robin, bluebird, native sparrows.

13. Tiger Beetles (Cicindelidæ), metallic colored, quite a number of birds.

IV. Diptera (metallic colored), catbird, swallows, flycatchers, etc.

V. Odonata (blue Agrion), green heron.

VI. Araneida (Argiope), dickcissel.

F. Protective Mimicry.

I. HYMENOPTERA (RESEMBLANCE AT LEAST).

1. ICHNEUMONIDÆ, most birds.
2. Siricidæ, see under warning coloration.
3. Chrysidæ, mimic Stinging Bees, many birds.

II. DIPTERA.

1. Syrphus Fly, mimics a Yellow Jacket, most flycatchers.
2. Drone Fly, mimics a Honey-bee, kingbird, phœbe.

III. TRICHOPTERA.

1. Caddice Flies, said to mimic Millers, many birds.

IV. COLEOPTERA.

1. Casnonia (Carabid), mimics an Ant, house wren, song sparrow.
2. Some Cerambycidæ, mimic Wasps:
   (*a*) Typocerus, blue jay, wood pewee.
   (*b*) *Leptura zebra*, red-eyed vireo, kingbird.
   (*c*) Cyllene, wood pewee.
   (*d*) *Neoclytus erythrocephalus*, song sparrow.
   (*e*) *Strangalia luteicornis*, kingbird.
3. Staphylinidæ, mimic Wasps, many birds.

The above tabulated matter is merely a collection of records, fragmentary and incomplete. It does not show the frequency with which any species of insect is selected for food by any particular bird, and consequently is liable to erroneous interpretation.

Insects which resemble the Substratum upon which they rest.

We will first proceed to ascertain whether those insects which exhibit protective coloration in its restrictive sense, that is, those that resemble what they rest upon, always baffle birds. We wish to determine how efficient this protective adaptation is; in a word, we desire to measure its working force.

In *Natural Selection*, p. 63, Wallace says: "The whole order of Orthoptera, *i.e.*, grasshoppers, locusts, crickets, etc., are protected by their colors, harmonizing with that of the vegetation or the soil on which they live." . . . On the next page he goes on to state: "We do not adduce any more examples to show how important are the details of form and

of coloring in animals, and that their very existence may often depend upon their being by these means concealed from their enemies." I am surprised to find that grasshoppers (Acrididæ and Locustidæ) in spite of their protective coloration are eaten by over three hundred species of birds in the United States.

Grasshoppers are eaten in large quantities by birds. They amount during the year, exclusive of the winter months, to 19 per cent of the volume of the insect food in the catbird, 25 per cent in the house wren, and 40 per cent in the meadow lark. In August 67 per cent of the red-winged blackbird's food consists of grasshoppers, and for the same month this staple amounts to 70 per cent in the meadow lark. For the two months of May and June grasshoppers amount to 80 per cent of the insect food of the loggerhead shrike. Of course, in the tropics, where we have such marvelous special adaptations as are found in the Mantidæ and leaf insects, there must be the most wonderful efficiency.

It may be argued that many of the grasshoppers eaten belong to the less protected forms, but we know that *Dissosteira carolina*, which is practically invisible on the ground, is selected, and that it is no uncommon thing to find the remains of several Locustidæ in stomachs. Whether these insects were taken when they were at rest, that is, when protective coloration is effective, is the great point and, so far as I have experimented with several birds, there seems every reason to believe that Acrididæ at least do not, when at rest, successfully baffle birds. I put several admirably protected grasshoppers (Acrididæ) among the fallen brown oak leaves, where I found them with the greatest difficulty, in a cage with a song sparrow, a junco, and white-throated sparrows. The legs of the insects had been pulled off, so they kept perfectly still, but the birds instantly saw and seized the grasshoppers. I tried the same experiment in a large cage with mocking birds and got the same results.

The great bulk of grasshoppers eaten by birds are Acrididæ, but stomachs containing a dozen Locustidæ are not at all uncommon. The Locustidæ most commonly selected belong to the genera Scudderia, Orchelimum, and Xiphidium. Of

the more especially protected Locustidæ we have the leaf-resembling katydids eaten by a number of birds of prey, and there are three cases on record of crow blackbirds eating full-grown walking-sticks (Diapheromera).

If we consider the number of grasshoppers (Melanopus) eaten by individual birds, it is interesting to note that the jaws and other remains of 48 grasshoppers were found in the digestive organs of one wood duck, 59 in a robin, and in a Swainson's hawk 133. These figures come from Professor Aughey, who made a study of the effect of birds upon an invasion of *Melanopus spretus*. Of course these insects were at the time so much in excess of all other species that it is only natural that they should have been taken for food. The same line of argument is applicable in the eastern United States during August and September, when many birds are subsisting to a large extent upon the abundant supply of orthopterous food. However this may be, it is a fact that in June and July, when there is no such superabundance of Orthoptera, birds nevertheless select principally from this order of insects to secure food to rear their young upon. I have no data to offer which will show how often any given grasshopper is passed over by a bird, and thus protected by its coloration being in conformity with its surroundings. I know full well that if these insects were colored a flaming red they would be much more conspicuous to us, and probably to the birds. From the little field work that I have been able to do, it seems to me probable that most grasshoppers are captured by birds not on the wing, but at rest or when moving very sluggishly. This summer, while collecting in a hayfield, I found it difficult to secure specimens of *Melanopus femur-rubrum*, which was very abundant. The insects arose at every step or so, but the instant they settled they became almost invisible. Protective coloration commenced to act as soon as they alighted. I watched an orchard oriole hunting in this field, but I failed to see any insects fly before her, though she at the time was feeding three young almost exclusively upon grasshoppers. From the little that I could see of a yellow-winged sparrow which was also feeding young, I was unable to see her flush

grasshoppers. This negative evidence is of little use. I had hoped to be able to make extended observations and perform a large series of experiments with caged birds, but have been unable to do so, and now can only offer a fragmentary contribution to this most interesting subject. Orthoptera along the Atlantic seaboard, in spite of their protective coloration, are fed upon extensively by practically all of our birds, and the degree of efficiency of their protective adaptation is probably low as compared with that enjoyed by many other insects.

The stomachs sent in to the Department of Agriculture are not accompanied with data as to the available supply of insect food. This material shows a much greater consumption of grasshoppers than I was able to find in stomachs which I collected in fields where grasshoppers were not up to their usual abundance. Although nestling birds were being reared largely upon grasshoppers, the parent birds were feeding upon insects which were less common than the grasshoppers.

Of the larvæ of Lepidoptera, the twig-resembling Geometridæ, which show a marvelous degree of special protective resemblance, are eaten by more than a score of birds of the eastern United States. The ground-colored cutworms, that so closely simulate the earth in which they live, are eaten by practically all the land birds which feed to any extent upon the ground. In the middle of May, 1898, I found that birds were feeding extensively upon Agrotis. The larvæ were abundant in the earth or under stones, but I saw none crawling about. Because of their nocturnal habits and protective coloration it is difficult to understand how the birds secured so many of them. During June and July, 1898, on a certain farm, I was unable to collect many specimens of noctuids and other protectively colored smooth caterpillars, but the birds seemed to have no trouble in finding them. Later in the season, however, during an infestation of *Protoparce carolina* in a tobacco field, no birds were found to select these protectively colored larvæ. Adult Lepidoptera as compared with the larvæ can hardly be considered as forming any significant part of bird food. The smaller inconspicuous moths seem to be relished by caged birds. These insects are occasionally preyed upon by the

majority of land birds. I have collected scores of birds in places where noctuid, crambid, pyralid, and geometrid moths were abundant, and not found a trace of a moth in any of the birds' stomachs. These insects, whether protected by their harmonizing coloration or by some other adaptation, are more immune from the attacks of birds than grasshoppers.

Weevils have a combination of protective devices; they are very hard-shelled, and they resemble either little stones or clods of earth. Moreover, they drop to the ground and feign death. Authors have dilated at length upon these admirable protective devices of weevils. But it seems to me that here we find the working force of protective adaptations at about as low an ebb as anywhere, for not only are these insects not immune, but they are eaten in great numbers by all insectivorous birds whose food we know anything about. It is not uncommon to find in the stomachs of such granivorous birds as sparrows as many as a dozen weevils.

32 Balaninus from downy woodpecker.
40 Sitones from crow blackbird.
109 *Dorytomus mucidus* from a hairy woodpecker.

The question with these weevils, as with grasshoppers, is whether they are caught while they are still and protective coloration is acting. I think that any one who has observed English sparrows and blackbirds hunting weevils on lawns can certify that many weevils are picked up from the vegetation or ground. Of course with flycatchers the case is often different, and the insects are taken on the wing. Experiments with caged birds should be carried on on a large scale. I confess that I have only experimented with one kind of bird and one kind of weevil. I sunk *Sitones hispidulus* in sand of its own color, so that only the back of the insect was uncovered. I could not see it, but the insect was seen as readily by my song sparrow as if it had been flaming red, white, and blue. In the dozen times this experiment was repeated the bird flew instantly and seized and swallowed the weevil.

I shot 45 birds on May 13 and 18, 1898, on a farm where I was only able to collect a single weevil. One-third of these birds had fed upon Sitones, Phytonomus, and Tanymecus.

One can hardly say in the face of these facts that the protective adaptations of these weevils is highly efficient in securing them from the attacks of birds. It seems as though birds became accustomed to discriminating between weevils and gravel stones, and, knowing how palatable weevils are, in spite of their hard covering, the birds seek them out, and even pass over apparently less protected insects.

In passing to the Hemiptera one finds that the homopterous division affords very little food supply to birds. The Jassids, as far as my experiments go, seem to be relished, but nevertheless they are not in large quantities habitually eaten by birds, in spite of the fact that they are very abundant. Whether it is their protective resemblance or some other device which secures them this degree of immunity from attack, I cannot say. The Aphididæ are still more protected. They are distasteful to catbirds, and, I imagine, to many other species.

Scale insects have been found only in the stomachs of several birds collected in winter, and in Baltimore orioles taken in summer. The true bugs (Heteroptera), which are protectively colored, are eaten by a great many birds.

Ground-colored spiders, whether taken while at rest or when running, are fed to the young of practically all the land birds of the eastern United States.

Hairs.

I next come to the consideration of special devices, such as, for instance, a hairy covering of the integument as we have in many caterpillars. With the exception of our two species of cuckoos no species of bird in the eastern United States, so far as I am aware, makes a business of feeding upon hairy caterpillars. The loggerhead shrike occasionally preys upon these insects, but with practically all other birds it is only in exceptional cases that a hairy caterpillar is eaten. I remember seeing an old pear tree which was infested with *Hyphantria cunea*. These insects were not at all molested, in spite of the fact that the old tree was tenanted by three broods of birds at the time — kingbirds, orchard orioles, and English sparrows.

An orchard oriole's nest with three young in another tree had a nest of hairy caterpillars within four inches of it. The hairiness of caterpillars seems to secure them from the attacks of birds more effectually than do any of the particular protective coloration devices thus far considered.

Stings.

The stings of Hymenoptera also serve as an effective protective device. A young sparrow, in whose mouth I inserted a small bee (Andrena), was stung in the throat, soon became very much affected, and finally I killed it to relieve its sufferings. A caged chewink seized a honey-bee, pecked it well and then swallowed it, but died within fifteen minutes. Mr. Benton, of the Agricultural Department, tells me that he had to give up raising ducks, because those just hatched ate honey-bees about the apiaries and were fatally stung. Nevertheless, I had a caged blue jay that would eat such large bees as Bombus and *Xylocopa virginica.* Flycatchers habitually feed upon stinging Hymenoptera, particularly upon Scoliids. The same is true of swallows, and the English sparrow is very fond of Tiphia and Myzine. Other birds occasionally take stinging Hymenoptera, less often large Apinæ. On May 18, 1898, I shot a catbird near a willow tree in which many bees were humming about the flowers, and the bird contained three small bees. The bird had a large supply of food, cutworms, beetles, etc., to choose from, but, nevertheless, took bees. It has been pointed out by Beddard that stinging Hymenoptera, in addition to being warningly colored, have disagreeable odors and tastes; it is also to be noted that many stinging Hymenoptera are not warningly colored, as the theory of protective coloration would, of necessity, demand them to be.

Among the ants there is a large division, the Myrmicidæ (the stinging ants). The smaller species of this division are eaten by a great many birds. Some of these ants have thorns on their abdomens which are said by Wallace to protect them from birds. More than any other protection perhaps is the formic acid which ants contain, but the efficiency of this device

seems low in cases where, as in the flicker, we find stomachs containing 3000 ants. The stingless ants pretend to sting, but there are many birds that they do not deceive.

There are two records of the caterpillar of the Io moth having been eaten by the yellow-billed cuckoo. In one instance no less than seven of these large stinging larvæ were taken from a single stomach.

It is plain that from my facts I interpret, not cases of protection and non-protection, but cases of greater and lesser efficiency of protective devices.

Ill-Flavored or with Irritating Qualities.

In the Heteroptera, particularly in the Pentatomidæ, we have insects emitting vile stenches. In speaking of the Pentatomidæ Comstock says: "It should not be concluded, however, that only members of this family possess this disagreeable odor; for most of the Heteroptera protect themselves by rendering their bodies unpalatable in this way. Doubtless birds soon learn this fact and leave such bugs alone." An English sparrow raised from the nest refused a Brochymena, and a song sparrow did not eat one of these insects, but ate with relish Lygus and small stinking Reduviids. In the examination of song-sparrows' stomachs I often find remains of Pentatomids, and I know of no insectivorous bird that does not eat Heteroptera. Catbirds and thrashers (caged) relish Brochymena. Blackbirds and crows frequently contain from four to ten Euschistus. The stench may protect bugs from some birds, but it certainly does not secure complete immunity from but very few birds of eastern United States. The lace-wing fly is about as nauseating an insect as I know of; yet it was greedily devoured by a caged song sparrow, and has been taken from the stomach of a great-crested flycatcher. Phalangidæ have a sickening stench, but they are eaten by many birds, particularly by house wrens and cuckoos. Millipedes come in the same category and are relished by birds.

In coming to the protective adaptations of Coleoptera we find a greater efficiency of the actual working of protective devices,

especially in the families Coccinellidæ and Chrysomelidæ. In the Coccinellidæ we have showy insects, ill-scented or flavored, that are eaten by but very few birds — the flycatchers and swallows; and hence here is a whole family which conforms well with the theory of warning coloration. Blue jays, song sparrows, thrashers, and other birds, when caged, refuse even when hungry these little beetles.

Turning to the family Chrysomelidæ, we have the potato beetle, that is refused by the catbird, blue jay, and song sparrow, and disgorged after being eaten by the thrasher. Several other examples might be mentioned, but when we come to the green Chrysomelids, especially the smaller ones, the efficiency is greatly reduced; the metallic tints that were supposed to always warn off birds are constantly disregarded, and we have many birds eating green Chrysomelids. Diabroticas are not often eaten and have been refused by song sparrows, but were greedily devoured by catbirds and thrashers. The elm leaf-beetle is almost protectively colored, but relies upon something else, perhaps its secretions, for protection. This insect is refused by many birds, but is occasionally eaten by the cedar bird. *Galerucella sagittaria* is also avoided.

The smaller Carabid beetles, whether stinking or not, seem to be eaten by practically all land birds. A song sparrow which was fed with a Chlænius was ill for twenty minutes, and then next day picked at but refused another. This same bird relished the stinking Nebria and Agonoderus. Crows, blackbirds, and jays relish *Calosoma scrutator*.

Crows and blackbirds have been known to feed Galerita, a very strong-smelling beetle, to their young. It seems incredible that birds should be able to eat Galerita, Calosoma, Carabus, and the larger Cychrus. Many birds eat species of Harpalus; the crow and the blackbirds are especially fond of *Harpalus caliginosus* and *pennsylvanicus*.

There are a score of smaller Carabidæ and Chrysomelidæ (metallicly and conspicuously colored) which are habitually eaten by birds that have an abundance of other insect food to pick from. On one farm I found fourteen species of birds preying upon *Odontata dorsalis*, and seven upon *Systena tæniata*.

With the Lampyrid beetles the stenches, whether or not coupled with conspicuous coloration, are more effective. Telephorus is occasionally eaten, but Photinus, if eaten at all, is taken only very rarely. Chauliognathus, though often so very abundant, is not eaten by many birds, but several species of flycatchers and swallows select this insect. Experiments with caged birds, catbirds, and blue jays showed that this insect was regarded unfavorably.

Warning Coloration and Mimicry.

The writers on protective coloration, especially Wallace, have stated that birds avoid insects that have metallic colors. Thus metallic coloration becomes synonymous with warning coloration. Although this is doubtless true in some cases, there are others in which it seems otherwise. The metallic beetles (Buprestidæ), certain Cicindelidæ, *Allorhina nitida*, *Euphoria fulgida*, *Cotalpa lanigera*, and Phanæus are relished by many of our common birds. And, further, it may be added that the metallic-colored flies, *Lucilia cæsar* and others, are found in large quantities in the stomachs of flycatchers and swallows; that is, in the stomachs of all birds that are swift enough to capture them. Large showy bugs colored like *Murgantia histrionica* are usually avoided by birds. A captive song sparrow refused a Murgantia, but a white-throated sparrow devoured it greedily. It is very seldom that I run across the remains of orange and black or red and black bugs during stomach examinations.

So much has been written on the subject of protective coloration of adult Lepidoptera that I cannot, even in this preliminary paper, pass over such an important chapter without stating some of the problems that here concern the student of protective coloration. I realize that in this order we have, especially in the tropics, very efficient methods of protection from birds, as has been shown by the investigations of Bates, Belt, Wallace, Triman, Poulton, and Beddard; but in the eastern United States the cases of efficient mimicry do not show up quite so well, for the reason that there are not yet any records

of birds habitually preying upon butterflies. In fact the same question has been agitated in the discussion following the reading of Mr. Dixey's most interesting paper at the London Entomological Society; and it was found that comparatively few members had ever seen birds take butterflies. In the eastern United States there have been hardly more than a dozen published records of birds seen in the act of taking butterflies. In fact birds, so far as I have observed, seem to make no practice of giving chase to the butterflies that float about them as they busily catch other insects. In fact butterflies seem to be avoided, whether they are indifferently colored, protectively colored or mimetic, or warningly colored. It is said by Wallace that our milkweed butterfly is imitated by Limenitis, which thus escapes capture; but, as none of our butterflies are persecuted, it seems strange if mimicry has actually been aimed at. Beddard has shown that there are difficulties in the theory of protective mimicry, from the fact that mimicking and mimicked forms are eaten, and that, in certain cases, instances of apparently useless mimicry occur. Beddard also shows some inconsistencies in the current interpretation of the theory of warning coloration. He shows that certain warningly colored papilio larvæ have a habit of not relying on their warning coloration, but conceal themselves. He further concludes, in speaking of warning coloration: "There are so many other easier ways of defense, and one would imagine that the action of natural selection would proceed along the line of least resistance." Some criticism in a measure adverse to protective mimicry is brought out in a paper entitled "Mimetisme," by M. C. Piepers, in the *Proceedings of the International Zoölogical Congress*, 1895, pp. 460–476. The greatest piece of work in actually putting the protective coloration theory to test has been accomplished by Frank Finn. The results of this investigation are published in the *Journal of the Asiatic Society of Bengal*, Vol. LXVI, Part II, No. 4, 1897. The author performed hundreds of experiments in feeding birds with butterflies. Mimetic, warningly colored, and non-protected butterflies were used. The birds employed included *Liothrix luteus*, *Otocompsa emerisa*,

Molpastes leucotis, *M. bengalensis*, *Pycnontus sinensis*, *Cratceropus canorus*, *Acridotheres tristis*, *Anthracoceros*, *Mesia argentauris*, *Dissemurus paradiseus*, *Dicrurus ater*, *Sturna menzbieri*, *Kittacincla macrura*, *Chloropsis aurifrons*, *Malacias capistrata*, *Turnix taigoor*. The experiments were made in cages and in an aviary. Mr. Finn's conclusions are:

"1. That there is a general appetite for butterflies among insectivorous birds, even though they are rarely seen, when wild, to attack them.

"2. That many, probably most species, dislike, if not intensely, at any rate in comparison with other butterflies, the warningly colored Danainæ, *Acrea violæ*, *Delias eucharis*, and *Papilio aristolochiæ*, of these the last being the most distasteful and the Danianæ the least so.

"3. That the mimics of these are at any rate relatively palatable, and that the mimicry is commonly effectual under natural conditions.

"4. That each bird has to separately acquire its experience, and well remembers what it has learned."

That, therefore, on the whole, the theory of Wallace and Bates is supported in this and my former papers, so far as they deal with birds (and with the one mammal used). Professor Poulton's suggestion that animals may be forced by hunger to eat unpalatable forms is also more than confirmed, as the unpalatable forms were commonly eaten without the stimulus of actual hunger — generally also, I may add, without signs of dislike."

Mr. Finn's elaborate series of experiments have proved that non-protectively colored butterflies are preferred to warningly colored ones. He notes the avoidance of the protected forms, but, in cases where they are eaten, fails to detect any signs of actual distaste. In fact there is, it seems to me, no hard and fast line between distaste and lack of preference. There is, however, in the mind of every one a distinct difference. For instance, I prefer beef to mutton, but this does not signify that mutton is distasteful to me. On the other hand, quinine and kerosene are actually distasteful. In applying the same standard to the case of the warningly colored butterflies I

should not, in spite of their not being preferred by birds, have called them distasteful. In my own experiments I have found that certain beetles are avoided to such an extent that birds will not touch them even when they are very hungry. Laying aside this quibble of the degree of distastefulness, it is clear that the lack of preference, however slight, is all that is required by the theory of protective coloration.

It would be exceedingly interesting to know to what extent the species of birds which Mr. Finn experimented with, feed upon butterflies when at liberty. I know of no native species of birds in the United States which habitually prey upon butterflies.

In the Linnean Society's journal, *Zoölogy*, Vol. XXVI, there is an article entitled "Natural Selection the Cause of Mimetic Resemblance and Common Warning Colours," by Professor Edward B. Poulton. The scope and aims of this masterly paper are so entirely different from those of my little contribution that I will not discuss it here. I have experimented in feeding butterflies to birds just enough to become confused. My song sparrow ate a *Papilio turnus;* a blue jay found a *Colias philodice* distasteful; while catbirds relished *Vanessa antiopa.* In spite of these experiments I must conclude, from the examination of stomach contents and field work, that butterflies are comparatively immune from the attacks of birds of the eastern United States.

Caddice flies are supposed to mimic small moths for protection, but they, nevertheless, are eaten by many birds, even when plenty of other insects are obtainable.

In the Diptera and Hymenoptera we have such swift-flying insects that birds have great difficulty in catching them. The Muscidæ are relished by most birds, but only the flycatchers and swallows are swift enough to catch them. The kingbird eats the Eristalis fly that mimics the honey-bee and also other mimicking Syrphus flies.

The parasitic Hymenoptera (Ichneumonids) are said to mimic the stinging ones, but they are eaten by many birds. It has also been supposed that many of our flower-infesting Cerambycid beetles mimic Scoliid wasps. However this may be, the

beetles are seldom eaten. A wasp-like Cerambycid *Neoclytus erythrocephalus*, however, was relished by a song sparrow. It is maintained also that Staphylinid beetles mimic stinging Hymenoptera; nevertheless, they are relished by a good many birds.

One of the most salient difficulties in the actual working of the theory of protective mimicry is met with when the insects eaten by the kingbird are examined. Here one finds that the yellow and black Hymenoptera, imitating Syrphidæ, are eaten by the kingbird. Further, that *Eristalis tenax*, which mimics the honey-bee so perfectly, is also taken. These facts, though bad enough for the effectiveness of the mimicry, are not to be mentioned in the same category with still another. The king-bird is well known to feed upon honey-bees, but, strangest of all, the bird seeks only the drones. This would lead one to infer that if a bird was keen enough to tell the different castes of bees apart on the wing, it would not be likely, to any considerable extent, to be humbugged by mimetic resemblance.

Mr. Benton, of the Department of Agriculture, tells me that domesticated fowls can tell the difference between drones and working honey-bees. Hens will stand by a hive and seize the drones as they come out, but do not touch the workers. In fact hens make a certain alarm cluck when they suddenly run across a worker.

Miscellaneous Matter.

Size often determines whether a given insect shall be eaten by a particular bird. The *Papilo turnus* which my caged song sparrow killed after several minutes of hard work would undoubtedly have escaped had it been outside, and a sphinx moth which my catbirds killed after a quarter of an hour's struggle would certainly have gotten away. So with many beetles. Small species can be easily managed; but a catbird, for instance, with a *Passalus cornutus* is helpless, while a blue jay has the strength to break the insect to pieces and then eat it. I gave a *Hydrophilus triangularis* to my blue jay. His beak glanced off the insect's back again and again, but finally he

struck it on the ventral side so as to disable the beetle, and then he hammered it to pieces and ate the soft parts.

The quick flight of Odonata and many Diptera prevent them from being captured in any quantities. I can offer no reason why the rose chafer is not a favorite article of bird food. I have often found this insect abundant where I have collected birds, but, with the exception of the kingbird, no bird seems fond of it. Catbirds captive and at liberty avoid the Colorado potato beetle. One adult catbird, however, shot where there was an abundance of food, had eaten a potato beetle. On the other hand, catbirds in captivity relish *Diabroctica 12-punctata* but avoid it when at liberty. I could give a number of other examples equally perplexing.

Conclusions.

It appears to me that certain writers upon protective adaptations have identified their specific cases as coming under the ban of the theory of protective adaptations in so far as they coincide with or do not run counter to a statement of Darwin's, in which he says that a necessary deduction from the theory of the definite facts of organic nature is that no special organ, no characteristic form or marking, no peculiarities of instinct or of habit, no relations between species or between groups of species can exist, but which must now be or once have been useful to the individuals which possess them. This statement of Darwin's has comparatively so little intention and is capable of such great extension that it forms a secure bulwark over which no armies opposed in the least degree to the theory of protective adaptations can ever hope to pass. It is as good as saying that every conceivable phase of animal life is a protective adaptation (a statement which I cannot deny). But it seems to me that there are different degrees of protective adaptations — that some are much more effective than others. There is need of some standard of the efficiency of protective adaptations, *i.e.*, a measure of their working forces. Some of the writers on the subject have led one to suppose that a good many protective devices secure almost complete immunity

from the attacks of birds; while other investigators have been tempted, when they found in particular instances that facts, apparently, did not coincide with current views, to abandon the theory entirely. Butler fully realizes the fact that very broad generalizations are almost impossible, since, as he states, there is no insect that will not be refused at some time by some birds, and there are no insects that one can be sure will not be eaten by some birds under certain conditions. Beddard, after reviewing his own experiments and those of Wallace, Butler, Weir, Morgan, Weisemann, and Poulton, states that there is the greatest difficulty in drawing broad conclusions; and he, moreover, points out the fact that, in the case of the insects that are refused, it is not usually on account of color alone, but more often for the reason of a collection of disagreeable attributes, such as spininess, conspicuous coloration, and bad flavor.

It seems to me that many caterpillars that have warning coloration are refused in part because they are hairy, because birds refuse inconspicuous hairy caterpillars as well as showy ones; and, moreover, cuckoos which feed upon hairy caterpillars do not avoid those of conspicuous pattern. Nevertheless, the hairiness of caterpillars must be ranked as highly efficient in protecting them from birds. The showy, ill-flavored Coccinellidæ may be awarded almost as high a place, and the elm-leaf beetle, not showily colored, should be rated even higher. The Diabroticas, Doryphoras, and several other similar beetles should be also reckoned as possessing comparative immunity from many birds.

Wherein lies the reason for the comparatively high scale of immunity of plant lice and rose chafers (Macrodactylus) I know not. It is a fact that the smaller Carabidæ, such as Anisodactylus, Amara, Nebria, Agonoderus, and Harpalus, are eaten much more frequently than Galerita, Carabus, and Calosoma. And from birds the size of sparrows and smaller it is doubtless true that large Carabids are well protected. Nevertheless, we know that the large insectivorous birds are not baffled by the irritating fluids these insects emit.

Among the Lampyridæ, Chauliognathus appears to have

almost as high a degree of immunity as Coccinellidæ. The quick-flying Diptera seem to be not far behind in the scale of immunity from the attacks of birds, but with aculeate Hymenoptera there is somewhat of a drop, and when we get to the parasitic Hymenoptera we find that they are eaten by many birds and apparently relished.

Among the Coleoptera, Cyllene and other conspicuous flower-loving Cerambycids are seldom found by the examiner of birds' stomachs. Meloids of the type Epicauta have, in their secretions, an efficient protection against birds, but they are exceptions. Thus, in each of five kingbirds' stomachs, taken in one locality, there were thirteen of these beetles. Butterflies, in the scale of efficiency of their protection, will rank a good deal higher than even Coccinellidæ. Homoptera, with the exception of Cicadas and Jassids, are seldom eaten. Dragon-flies are not often caught when they have once been safely launched on the wing, but May flies and Caddice flies are terribly persecuted.

Apparently irrespective of coloration, the smaller Carabidæ, and particularly all abundant Scarabæidæ, except the rose chafer, are eagerly sought after for food by most insectivorous birds.

From the study of the insectivorous food of birds, it seems to me that biologists have not yet entirely elucidated all the details of the nature of the adaptations of insects which are most potently protective. Some investigators seem to reason from the standpoint of man: that since an insect tastes bad in our mouth, therefore it must be distasteful to a bird. What is one man's meat may be another man's poison. Consequently it seems to me that the human criteria are not necessarily adapted to suit the avian case. It does not follow that, since a stink bug nauseates our stomach and irritates our tongue, it will produce a like effect on a crow. Hence there appears to be need of a little more avian psychology before it is possible to entirely coincide with certain current views upon protective adaptations.

Numerous species of bugs and beetles which, in addition to being protectively colored, possess ill-smelling, bad-tasting, and

irritating secretions, would naturally be supposed by some writers to be avoided generally by nearly all birds, *but they are habitually eaten* by many birds of the eastern United States. This would lead one to infer that protective adaptations in our country are not always so efficient in securing insects from birds as has been commonly held.

The fact that beetles and other insects which are gaudily colored — and consequently are supposed to be protected from birds — are greedily devoured by many birds, appears to show that warning coloration is not always as efficient as alleged, and one is almost led to believe that, because of this inefficiency of warning coloration in many cases, protective mimicry has been in some instances overestimated. Even the theory of protective coloration in its restrictive sense, when pitted against some facts, apparently loses a little of its luster in certain cases; and we are forced to admit that factors may exist which sometimes nullify its action, so that the alleged protective coloration is not the all-important factor in securing an insect from extermination, as some earlier naturalists have supposed, but that there are other equally important factors that demand consideration. That is to say, coloration is not all, but only one of the determining elements.

NOTE ON THE VERTICAL DISTRIBUTION OF MALLOMONAS.

G. C. WHIPPLE AND HORATIO N. PARKER.

Mallomonas is a microscopic organism that is often found in the water of ponds and lakes. It usually occurs in greatest abundance in the spring and autumn, but occasionally it appears at other seasons. It is an odor-producing organism, and as such is liable to give trouble in water supplies. Its odor is similar to that of Cryptomonas, which has been described as resembling "candied violets." As the odor increases in intensity it loses its aromatic qualities and becomes "fishy." In addition to its odor it has a slight sweetish taste. Mallomonas is not known to have ever given serious trouble in a water supply, because it is seldom found in large numbers for any considerable length of time, but several cases are on record where it has been present in water supplies, and where it has undoubtedly caused a noticeable odor. Observations seem to indicate that whenever it is present in the water to the extent of about 500 per cc. its odor may be recognized. However, this paper is not concerned with the odor-producing properties of Mallomonas, nor its effect on water supplies, so much as with the organism itself, its structure, its development, and especially its peculiar, characteristic, vertical distribution in ponds and lakes.

The earliest description of Mallomonas was that of Perty in 1852. To him we owe its generic and specific names. Some writers have questioned the claim of Mallomonas to rank as an independent genus. Stein held that it was but a monad of Synura, freed from its colony. Recent observations have established the position advanced by Perty and adopted by Kent.

Kent's description of Mallomonas is as follows:

Genus Mallomonas Perty.

Animalcules free-swimming, oval or elliptic, persistent in shape; cuticular surface indurated, clothed with long, non-vibratile, hair-like setæ; a single,

long, vibratile flagellum produced from the anterior extremity; contractile vesicle indistinctly developed. Inhabiting fresh water.

M. PLOSSLII PERTY.

Body ovate or elliptical, slightly narrower anteriorly, cuticular surface finely shagreened or crenulate, thickly clothed with fine hair-like setæ, whose length is less than that of the body; flagellum long and slender, retractile; endoplasm vacuolar, amber color or greenish-yellow; contractile vesicle indistinct, posteriorly located. Length of body, 1-1000″ to 1-900″. Habitat marsh water.

This description is somewhat incomplete and does not take into account certain common variations from the type form. Examination of a large number of specimens found in the waters of Massachusetts and New York has revealed the following facts:

The length of Mallomonas varies at different times and in different localities from 20 to 60 μ. The ratio of length to width varies from 4 to 1. Sometimes the bodies are long and narrow, and sometimes they are almost spherical, resembling the Rhizopod, Actinophrys. The older forms are somewhat more spherical than the younger ones. All forms of Mallomonas are more or less spherical in end view.

The setæ or spines vary in length from 15 μ to 30 μ; the average length is about 25 μ. They have a diameter of 0.3 μ at the base and taper to a point at the fore end. They are generally straight, but, being flexible, they sometimes appear to be curved. At the base they bend sharply like a polo stick and are attached to basal plates which have a rectangular shape. It is the irregular lapping of these basal plates that produces the corrugated appearance of the cuticular surface mentioned in Kent's description. The setæ are easily broken off, and it is not uncommon to see specimens with only two or three setæ present. When the organism moves forward the setæ are directed backwards.

The color of the organism is usually green when the specimen is young and fresh, but sometimes it changes to greenish-yellow or brown. Besides the two chromatophores, a contractile vacuole and numerous oil globules may be discerned. The

nucleus, if present, is indistinct. At times a globular, balloon-like body is attached to the posterior extremity. It is apparently a development of the contractile vacuole. It is usually small and colorless, with a granular structure, but sometimes it is large, green, and spore-like. This body may be connected with some process of reproduction. Reproduction of Mallomonas takes place by sporular encystment. The protoplasm contracts, assumes a spherical shape, shrinks, and becomes invested with a thin integument. A single spore is formed by each individual. The liberated spores have a brown color and are occasionally surrounded by a gelatinous tegument.

All the forms of Mallomonas observed by the writers, notwithstanding their variations in size and shape, may be properly included under the single species *M. plosslii* Perty.

Fresenius (*Infusionsthiere*, Abth. III, 1878) described a minute form, to which the name *M. fresenii* has been given. Zacharias (*Forschungsberichte*, Theil I, s. 16) has described a species which he calls *M. acaroides* Zach. It differs from the type form only in having the setæ thicker and more curved than those of *M. plosslii* (*Vergl. zur Kenntniss kleinsten Lebensformen*, 1852, s. 83). He has also described (*Forschungsberichte*, Theil I, s. 73) a new variety which he has called *M. acaroides* Zach. var. *producta* (Seligo). It differs from the previous form by its larger size and by its longer spines. Seligo (*Ueber einige Flagellaten des Süsswasserplankton*, Jan. 3, 1893), under the name Lepidoton, has described the same form.

Mallomonas is of interest to students of aquatic life because of its peculiar vertical distribution during the summer. Three instances of this are on record; namely, in Lake Cochituate and Whitehall Pond, of the Boston supply, and in Ridgewood Reservoir, of Brooklyn, N. Y.

Lake Cochituate is a lake of almost colorless water, with a maximum depth of sixty feet and with well-marked stagnation periods. Mallomonas is often found there in numbers varying from 50 to 100 per cc. On June 24, 1896, it suddenly appeared in the lower strata of water near the gate house. There were 116 per cc. at the mid-depth thirty feet, 42 per cc. at the bottom sixty feet, but none at all at the surface. The follow-

ing week the same peculiar distribution was observed, the surface water being free from them, while the number at the mid-depth was 336 per cc. This arrangement continued until the first of September. During all this time not a single individual was observed at the surface, and the numbers at the mid-depth fluctuated between wide limits, on one day being as high as 3640 per cc. At the bottom they were invariably present, but always in much smaller numbers than at the mid-depth. The following table gives the number of Mallomonas at the surface, mid-depth, and bottom for the entire period of growth.

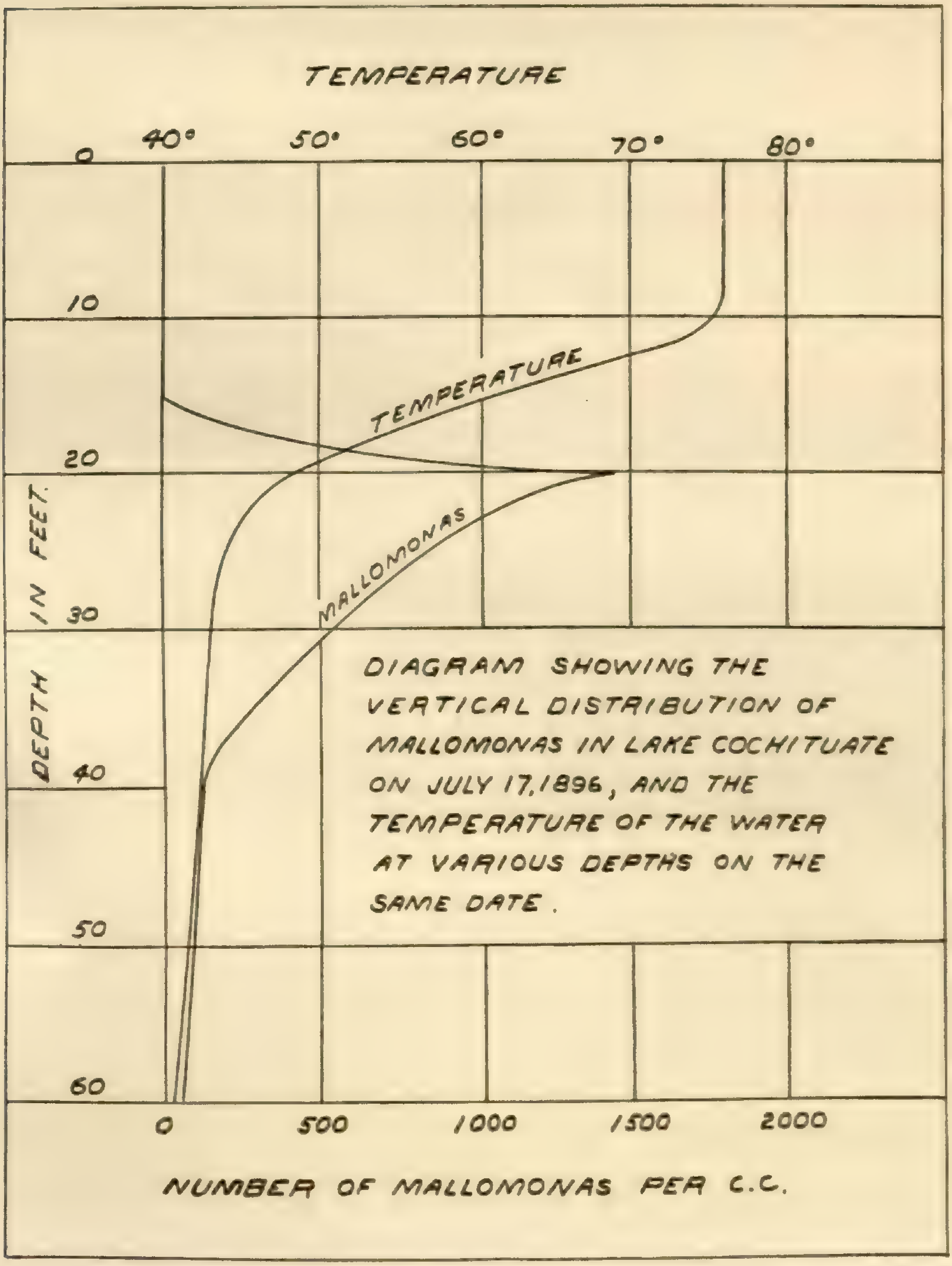
	Number per cc.				Number per cc.		
Date.	*Sur.*	*Mid.*	*Bot.*	*Date.*	*Sur.*	*Mid.*	*Bot.*
June 18,	0	0	0	July 28,	0	264	162
24,	0	116	42	Aug. 4,	0	3640	6
July 1,	0	336	2	11,	0	1200	10
8,	0	46		18,	0	1380	4
15,	0	724	276	25,	0	298	8
22,	0	1102	158	Sept. 1,	0	0	0

On July 17 a series of samples was taken at intervals of ten feet through the vertical, and the following results were obtained.

Depth.	Mallomonas per cc.
Surface.	0
10 ft.	0
15 ft.	2
20 ft.	1454
25 ft.	794
30 ft.	548
40 ft.	112
50 ft.	88
60 ft.	64

These figures, together with the temperature of the water at various depths, are shown by the diagram. It will be observed that the greatest numbers were found just below what may be called the thermocline. From the surface down to a depth of ten feet the temperature of the water was uniform. Between ten and twenty feet the temperature fell rapidly. The water in this stratum was not stagnant, however, as other observations — not given here — indicated. But below a depth of twenty feet

the temperature was practically constant from week to week, indicating a condition of stagnation. It was at the boundary line between the stagnant water and the slowly circulating



water above it that the Mallomonas reached their greatest growths. Below this depth the numbers decreased rapidly.

A similar case of vertical distribution occurred in Whitehall Pond during the summer of 1897. This is a pond of dark

brown water, with a depth of about twenty-five feet. From May 7 to June 7 the surface samples contained a few Mallomonas. On June 14 there were 110 per cc., after which there were less than 11 per cc., until August 23 they suddenly rose to 2186 per cc. This suggested that there had been a growth at the top of the stagnation layer as in Lake Cochituate, and that a high wind had stirred the water and brought the organisms to the surface. This seemed the more probable, because the color of the surface water, which had been 0.57, rose to 0.66. On August 27, four days later, samples were taken every five feet from surface to bottom. The following results were obtained.

Depth.	Number of Mallomonas per cc.	Color.
1 ft.	20	0.54
5 ft.	880	0.54
10 ft.	1936	0.57
15 ft.	84	0.64
20 ft.	40	1.06

These observations seemed to show that there had been a large growth below the thermocline, that the organisms had been scattered through the water, and that they were now sinking back toward their original position. The color readings showed that the pond had been stirred to a depth of only about fifteen feet.

On September 14 the vertical distribution was as follows.

Depth.	Number of Mallomonas per cc.
1 ft.	0
5 ft.	0
15 ft.	10
20 ft.	432
25 ft.	472

In November, during the period of autumnal circulation, Mallomonas again appeared at the surface, the number per cc. reaching forty.

This tendency of Mallomonas to concentrate just below the thermocline was observed in Ridgewood Reservoir, Brooklyn, N. Y. In July, 1898, on the 6th inst., the water at the surface contained 60 per cc., while at the bottom (twenty feet) there

were 156 per cc. At a depth of fifteen feet they were more numerous, but the actual number per cc. was not determined. On July 14, after a high wind, the surface water contained 420 per cc.

The reasons for the peculiar vertical distribution of Mallomonas are not wholly apparent, but the reactions of the organism to light and temperature offer some suggestions.

Mallomonas possesses a strong heliotropism. This has been shown by laboratory experiment. A brass tube having glass ends was filled with water containing 3360 Mallomonas per cc., and so placed that one end was exposed to the light, while the other was covered by a black cap. After standing for forty-eight hours in a horizontal position, portions of the water were carefully withdrawn simultaneously from each end of the tube and examined. At the dark end of the tube only 810 Mallomonas per cc. were found, but at the light end there were 9480 per cc.

From this tendency to move towards the light, it would appear that the Mallomonas had tried to get as near as possible to the surface where the light was strongest, but that the warm, agitated water above the thermocline did not offer favorable conditions for growth. During the winter Mallomonas does rise to the surface, and is usually more abundant there than elsewhere in the vertical.

Apparently Mallomonas prefers to live where the light is strong, where the temperature is low, and where the water is quiet. No doubt the long setæ (and possibly the balloon-like bodies referred to above) help to keep the organisms from sinking in quiet water. These become broken off when the water is violently agitated, and after that the organisms sink more readily. This may partially explain why Mallomonas does not develop near the surface during the summer.

THE COLORS OF NORTHERN MONOCOTYLEDONOUS FLOWERS.

JOHN H. LOVELL.

In the accompanying table the 1058 species of northern monocotyledonous flowers recognized in the *Illustrated Flora of Britton and Brown* have been arranged according to their predominant colors. The territory covered extends from the Atlantic Ocean westward to the 102d meridian, and from the parallel of the southern boundary of Virginia and Kentucky northward, to include Labrador and Manitoba. The green or dull-colored flowers number 857, and the non-green 201, of which 41 are yellow, 82 white, 22 red, 22 purple, and 34 blue. Of the 28 families, 12 contain yellow flowers, 11 white, 5 red and purple, 5 blue, and 15 green. Six families are represented by only a single species. Yellow and white flowers usually occur in the same families, except in the Alismaceæ with 19 white, and the Xyridaceæ with 6 yellow species. There are described in the sixth edition of *Gray's Manual* 785 monocotyledons, which, for the purpose of comparison, I have also tabulated according to their colors; 621 have green or dull-colored flowers, and 164 non-green, divided into 38 yellow, 67 white, 19 red, 19 purple, and 21 blue. The yellow, red, and purple are less than those of the *Illustrated Flora* by 3 each, the white by 15, the blue by 13, and the green by 236. This difference is due partly to the more restricted area of the *Manual*, and partly to a different conception of varieties and species.

The flowers of the four families, Typhaceæ to Scheuchzeriaceæ, are either anemophilous as in Typha and Potamogeton, or hydrophilous as in Ruppia and Zostera, or self-fertilized as is probably the case in Triglochin and Scheuchzeria. The perianth segments are very small or wanting, and the numerous flowers are usually crowded in a greenish inconspicuous inflorescence which is often spathaceous. The spikes of Typha

are, however, brown or black, and those of Potamogeton are frequently reddish. The 19 species of the Alismaceæ all have white petals and are attractive to Syrphidæ. On the small flowers of Alisma Plantago-aquatica, Müller collected 5 flies of this genus, and on Sagittaria latifolia I have taken 11 Syrphidæ, 6 other Diptera, 2 Coleoptera, and 4 bees. In the latter species the globular mass of yellow stamens, about 40 in number, are brought into strong relief by the white petals. The primitive color of the Alismaceæ was doubtless green, the transition of which to white may be illustrated by many examples. The involucre of Cornus changes from green to white during growth; the floral leaves of *Monarda clinopodia* are white; the calyx of Polygonum in different species is green, greenish-white, and white; the upper sepal of *Habenaria obtusata* is green with whitish margins; the perianth of *Ornithogalum umbellatum* is white above and green beneath; Chrosperma (Amianthium) is white, but turns greenish with age; I have observed the marginal neutral flowers of a culture variety of Hydrangea to remain upon the plant for many months and change from white to pale green, and many small flowers vary from green to white. Of the Vallisneriaceæ Philotria and Vallisneria have white hydrophilous flowers, and Hydrocharis is entomophilous. Müller regards Vallisneria as an intermediate stage between a water-fertilized and an insect-fertilized plant.

The Gramineæ with 371, and the Cyperaceæ with 334 species include nearly two-thirds of northern monocotyledons. The same external conditions appear to have been favorable to the development and continuance of a great number of forms in both families. The flowers are wind fertilized, though they are visited occasionally by flies, bees, and beetles for pollen. The perianth is nearly suppressed and is represented only by scales or bristles. Both the glumes of the Gramineæ and the bracts of the Cyperaceæ are often reddish or purplish. This coloration is of physiological importance, according to Pick and Stahl, and by converting light-rays into heat promotes both in young leaves and the organs of flowers transpiration, metabolism, and growth. Darwin states in "Variation in Animals and

Plants under Domestication" that red wheats and red sugar canes are more hardy than white, and I have also noticed that the most vigorous variety of maize or Indian corn in my garden had purplish-red culms, glumes, and silk. The red coloring of the styles is believed to favor the growth of the pollen tubes and occurs in many flowers. Leaf variegation is found in some grasses, as in Eulalia, one beautiful variety of which has the leaves striped longitudinally with white, and in another marked transversely with yellow.

Many Araceæ are cultivated for their handsome foliage, which is marbled or striped with yellow, white, purple, and red. The capability of the leaf to produce bright coloration has determined the adaptation of the spathe for attractive purposes, and its development has been attended by the reduction or suppression of the perianth. The spathe of *Arisæma triphyllum*, Indian turnip, is variegated with purplish and white stripes, and C. M. Weed found the flowers visited by small diptera of the genus Mycetophila, or family of fungus gnats. *Symplocarpus fœtidus*, the skunk cabbage, has the spathe spotted and striped with purple and yellowish-green; the odor is repulsive, and the visitors are small active flies of the genus Phora. *Calla palustris* has a conspicuous white spathe and, according to Eu. Warming, pond snails aid in the fertilization; Delpino mentions more than 4 European species of Araceæ, which, in his opinion, are fertilized by snails. In Orontium the perfect bright yellow flowers are densely crowded over the narrow spadix, and the green spathe is distant, investing only the lower part of the scape. The investigation of the numerous tropical species of this family promises to reveal many remarkable adaptations. The Lemnaceæ are regarded as simplified Araceæ, and the minute green flowers, in the opinion of Ludwig and Müller, are adapted to insects which live upon the surface of the water.

The small yellow flowers of the Xyridaceæ, which are regular, trimerous, and solitary in the axils of scale-like bracts, are evidently primitive in type, and are probably derived directly from ancestral green forms. This transition is illustrated in Hypoxis, which has the perianth segments yellow above, but

the three outer green on the lower side; in *Nymphæa advena* the lower half of the outer sepals is green, and the upper half yellow; *Trollius laxus*, which grows in dense swamps, has greenish-yellow sepals, but the culture varieties are bright yellow, while the perianth of *Veratrum viride* is yellowish-green. Henslow thinks it probable that the yellow coloration of the petaloid structures is correlated with the yellow coloring of the anthers and pollens, universal among gymnosperms and very prevalent among angiosperms, and also extending to the anther scale of Pinus and the sporophylls of Lycopodium. Certainly yellow is the first color to be developed in many dicotyledonous families.

The 12 species of the Commelinaceæ all have blue flowers, except *Tradescantia rosea*, which is rose-colored, and the smallest northern species with narrow grass-like leaves and few flowers. Blue in this family appears to have been preceded by a reddish stage, and this view is strengthened when we remember that many blue Boraginaceæ have passed through a red stage, as Myosotis, Pulmonaria, and Echium, several species changing from red to blue during the course of individual development. The filaments of Tradescantia are bearded as in Verbascum, which is visited by pollen-collecting bees.

The original color of the Pontederiaceæ was almost certainly yellow, as it still is of the smallest species, *Heteranthera dubia*, water star grass, which has a slender stem and linear, sessile leaves. Every stage of the transition from yellow to blue is shown by *Viola tricolor*, and in Gentiana the simplest species, *G. lutea*, is yellow, but the more highly specialized species are purple-blue. The middle lobe of the upper lip of *Pontederia cordata* is marked by two yellow spots, which serve as honey guides. This is one of the handsomest as well as commonest of river plants, producing thousands of spikes of purple-blue flowers with blue anthers. The most important visitors are *Bombus vagans* and *B. borealis*, though I have also collected upon the flowers two other bees, four Lepidoptera, and four Diptera.

The Juncaceæ have a small, regular six-parted perianth which is often reddish or purplish brown. The flowers are anemo-

philous and proterogynous, though self-fertilization of open flowers and cleistogamy occur. Several European species have rather conspicuous flowers and attract insect visits.

The Melanthaceæ have regular, perfect, and, for the most part, small flowers in panicles and racemes. Many of the species grow in woodlands and swamps, secrete nectar in readily accessible positions, and are visited by Diptera, as in Tofieldia and Veratrum. The flowers exhibit but little bright coloring and are chiefly greenish-white or greenish-yellow; in Zygadenus and Melanthium there are green, greenish-yellow, and greenish-white species; in Veratrum yellowish-green and purplish. Yellow, white, and purple appear to have been developed directly from the primitive green without passing through any intermediate stage. There is a complete absence of red and blue and of variegation. The primitive color of this family and the two succeeding was undoubtedly green, resembling the wind-fertilized Juncaceæ, with which they are closely allied in structure.

The Liliaceæ have attained a much higher stage of coloration than the Melanthaceæ, and the inflorescence exhibits the most brilliant and variegated hues. The flowers are solitary or clustered, very large and conspicuous, and, in some instances, adapted to the visits of a single species of insect. They are very remarkable for their range of color and, long since, compelled botanists to lay aside the cyanic and xanthic speculations of de Candolle. The hyacinth displays every shade of yellow, white, red, and blue, and Darwin gives several instances of red and blue flowers produced on the same truss; the tulip exhibits yellow, white, red, and purple-violet; and many other genera are almost equally polychromatic. The 9 species of Allium are green, white, and rose, the development of coloring having proceeded in this order. The honey is abundant and is more accessible in the green and white species than in the rose; the inflorescence is umbelloid, and the guests are bees, Lepidoptera, and flies. Florists also offer bright yellow and blue forms. About 45 species of the genus Lilium are known, many of which are adapted to diurnal and nocturnal Lepidoptera. The entire genus is justly admired for the beauty of its flowers.

It has long been a favorite in floriculture and many varieties have been produced by hybridization. Seven species with yellow, orange-red, and scarlet flowers are indigenous to the northern states, and *L. tigrinus* is adventitious from Asia. Red flowers are peculiarly attractive to butterflies, and they are the chief agents in pollenizing many pinks and species of phlox, and, according to Müller, of Tritoma and the fiery red *L. bulbiferum*. I have repeatedly seen *L. Philadelphicum*, which is orange-red spotted with purple inside, visited by *Argynnis aphrodite*, the silver-winged butterfly, which is itself yellowish-red spotted with silver, but never by any other insect. The yellow nodding flowers of *L. Canadense* are visited only by bees, and I have seen *Bombus vagans* rest first upon the stigma and then climb the stamens to the base of the corolla. The white exotic species, such as *L. martagon* and *L. harrisi*, are sought by Sphingidæ or hawk moths. The genera Lilium and Tulipa excellently illustrate the transition from yellow to red, presenting every intermediate step, as yellow, orange, orange-red with a broad yellow band, orange-red, dark scarlet with yellow stripes, and fiery red. *Tritoma abraria* is coral red and, according to Gray, changes to orange and then to greenish-yellow.

Erythronium, Calorchortus, and Muscari are visited by bees, and display the most brilliant colors. The 4 native species of Erythronium are respectively yellow, white, rose, and lavender; and those of Muscari are blue and white, but under cultivation there are also yellow and red forms.

The genus Yucca is chiefly confined to Mexico and the southern states, but 3 species occur north of Tennessee. The flowers are large, white above and greenish beneath, and are pollinated at night by a white Teneid moth, *Pronuba yuccasella* A plant in bloom is a magnificent sight, the flower stalk sometimes, as in *Y. filifera* of Mexico, rising to the height of 50 feet and supporting a panicle 5 or 6 feet long. The manner of pollination is phenomenal in the extreme and has been thoroughly investigated by Riley and Trelease. The structure of the moth Pronuba is very abnormal among lepidopterous insects, as it is provided with tentacles for collecting

pollen and an ovipositor for puncturing the yucca pods. In the evening this small moth climbs in succession half a dozen stamens, and collects the pollinia in a compact ball beneath its head; it then punctures the pod and deposits its eggs among the ovules, after which, in order that the growing seed pods may afford food for the young larvæ, it deliberately climbs the short style, and intentionally rubs the pollen with its tentacles upon the viscid stigma. As the stamens are shorter than the pistil the plant would not produce seed unless fertilized by Pronuba.

The Convallariaceæ commonly grow in moist woods and thickets, and have dull-colored, rather inconspicuous flowers. Of the 23 species 2 are greenish-yellow, 11 white, 1 rose-purple, 4 purple, and 5 green; there are no bright red or blue flowers, and none adapted to Lepidoptera. The most frequent visitors are bees and flies. The greenish flowers of Asparagus are mellifluous, pleasantly scented, and mellitophilous. The male flowers are twice the length of the female, and in consequence of their increased conspicuousness are visited first by bees. On the greenish-yellow flowers of *Clintonia borealis* I have collected the honey-bee, *Bombus consimilis*, and small beetles, *Anthobium pothos*, feeding on the pollen. The short, white, bell-shaped flowers of Convallaria are open to all bees, but the longer tubular blossoms of Polygonatum only to bumblebees. The largest genus is Trillium with 8 species; 3 white, 4 purple, and 1 greenish. The purple-flowered species have been derived, apparently, directly from the primitive green, for *T. viride* is light green or purplish-green, *T. erectum* is purple, sometimes greenish, and *T. sessile* is purple or green. A white variety of *T. erectum* is common, especially in New York, the specimens of which in my herbarium are smaller than the purple form. C. M. Weed saw the flesh fly, *Lucilia cornicina*, on the flowers of this species, which has a disagreeable odor, and I have also seen minute Diptera. Several species are pleasantly odorous and are probably visited by small bees. The Smilaceæ have small, regular, diœcious, greenish flowers attractive to Diptera.

The Amaryllidaceæ are principally a tropical family, only

1 species, *Hypoxis hirsuta*, star grass, being found in New England. The flowers are often white, sweet-scented, and attractive to night-flying Lepidoptera. Of the 6 northern species, 3 are yellow and 3 white. The coloration of the exotic species is unsurpassed in beauty and magnificence, orange, white, red, and crimson predominating.

In the Iridaceæ, on the contrary, blue, violet, purple, and yellow are the more common colors, often variegated and gaudily spotted. The flowers of Iris are adapted to the larger bees, though the bright yellow *I. pseudacorus*, naturalized from Europe, has been seen both there and in New England to be frequently visited by a syrphid fly of the genus Rhingia. On *I. versicolor* I have taken four different bees; the honey-bee often passes in and out sideways between the perianth segment and the petaloid style without effecting fertilization, and *Halictus similis*, also common, I have observed breaking open immature anthers for the pollen. Yellow markings, yellow flowers, and reversion to yellow are of frequent occurrence, especially in Iris and the familiar Gladiolus and Crocus, and point to this color as belonging to an earlier stage of this family.

At the head of the monocotyledons stand the magnificent and extensive family of the Orchidaceæ, which, according to Engler, has no possible connecting link with the liliaceous families. The flowers are zygomorphous in a very high degree and possess marvelous adaptations for fertilization by insects, which have been very fully described, but can only be properly understood by the examination of living specimens. Of the 61 northern species, 10 are yellow, 18 white, 8 red, 14 purple, and 11 green. The number of white and green flowers appear surprisingly large until it is observed how sparingly our indigenous species are visited by insects. There are no blue flowers, and this is an unusual color among orchids, though found in the pale blue *Vanda cærulæ* of India. There is much variegation, and reversion to white of the pink-purple forms is common as in *Habenaria grandiflora* and *Pogonia ophioglossoides*. Many of the large pink-purple or rose-colored flowers are attractive to bumblebees. *Orchis spectabilis* blooms in early springtime and is visited only by female forms of Bombus, which are then

alone on the wing; during two years I have repeatedly examined many blossoms of the handsome *Pogonia ophioglossoides*, but have collected only a single specimen of *Bombus consimilis*. The white flowers of Gyrostachys (Spiranthes) and Peramium (Goodyera) are also occasionally visited by bumblebees. The genus Habenaria is adapted to Lepidoptera, the white and yellowish species, which are often sweet-scented, being pollinated by crepuscular or nocturnal moths. In some instances I have found the grayish hairs of these insects adhering to glutinous surfaces. The fertilization of some 10 species has been described by Asa Gray. Small purplish or green flowers are visited by small Hymenoptera and Diptera or are self-fertilized. On the purplish and greenish inflorescence of Listera, twayblade, Darwin collected in England small Hymenoptera and Diptera, and on the extremely small and inconspicuous but odorous flowers of *Herminium mornorchis* George Darwin collected 27 specimens of minute Hymenoptera, Diptera, and Coleoptera, the largest being less than $\frac{1}{25}$ of an inch in length. The small green flowers of *Habenaria hyperborea* and *Epipactis viridiflora* are self-fertilized. Scentless plain green flowers of a species of Epidendrum in South Brazil, according to Fritz Müller, freely secrete honey and attract insects.

A simpler and earlier stage of the Orchidaceæ has been partly preserved in Cypripedium, the floral organs of which are less modified than those of other genera. An enormous amount of extinction, Darwin believes, has swept away the intermediate forms. The flowers are visited with extreme rarity by Andrenidæ, while species of Bombus are liable to be held captive and perish miserably of starvation. Of the 6 species in the northern states, 2 are yellow, marked with purple, 2 white striped with purple, and 2 red and white. As the lip is evidently the chief object of attraction the other perianth segments are dull colored, green, brown, white, or purple.

The Orchidaceæ are remarkable for the variety of colors, often three or four, presented by individual flowers; in a species of Dendrobium from India the sepals and petals are white, tipped with purple, and the lip is bright orange with two crimson spots. This is probably due to the marked tendency of

the species to variation, as described by Müller and others, and to which they attribute the multiplicity of forms of flowers. The high degree of zygomorphy and bright coloration have evidently been produced by the agency of insects, since the lip, the petal most modified in form and color, is the segment most visited, while the other segments of the perianth often retain their primitive form and plain green coloring. Insects have not, however, been able to induce particular colors, but their work has been the fixation by selection of those naturally produced by the flowers. This is well shown by the rarity of blue among the Orchidaceæ. This color is very attractive to bees, yet its development has not necessarily followed the high specialization of the flowers in response to their visits. Its presence or absence is rather dependent upon the chemical constitution of the nutritive fluids or other internal conditions. There may even be no bright coloring, as in the mellifluous plain green species of Epidendrum mentioned above.

The monocotyledonous families were probably very early differentiated, and their subsequent development has proceeded along parallel lines, but without any connection with each other. With few exceptions, the families possess a perianth, though it is frequently rudimentary, and in the majority of species non-petaloid. In the opinion of Engler the floral envelopes have not been induced by insect pollination. Their very general occurrence points to their early development, and their first office was undoubtedly protective in its nature, similar to that performed by the scales of the gymnosperms. In anemophilous families the perianth has remained unmodified or, where the protective office has been assumed by glumes or bracts, as in the Gramineæ, has nearly disappeared; while in the entomophilous families insect pollination has caused it to be enlarged and specialized. When the expenditure of producing petals, nectar, and color is considered, as well as the vast number of individuals blooming at a time when they would be brought into competition with many entomophilous flowers, it cannot be doubted that the Gramineæ and Cyperaceæ are more efficiently pollinated by the wind than could possibly be the case by the existing number of insects.

Summary.

1. The primitive color of the perianth of the monocotyledonous families was green, as it still is in the greater part of the species which are anemophilous or self-fertilized. A few of the oldest families, with an indefinite number of stamens and carpels spirally arranged, have probably never possessed floral envelopes.

2. Yellow, white, and lurid, or greenish-purple flowers have in numerous instances been derived directly from the primitive green; red flowers have passed through a yellow or white stage; and blue and purple-blue have been derived from yellow, white, or red forms. Reversion to white is most common, but reversion to red or yellow also occurs.

3. Physiological conditions appear to have often played an important part in determining the coloration of the petals, while "insects have contributed to the fixation of such characters when once acquired."

4. In general, among monocotyledons yellow flowers are visited by bees and flies; white flowers, by bees, nocturnal Lepidoptera, flies, and beetles; lurid-purple, by flesh flies; red, by bees and butterflies; and blue, chiefly by bees. Red and blue flowers usually have the honey concealed, which is a far more effective cause of the limitation of insect visits than color.

When the honey is abundant and exposed, and the flower pleasantly odorous, it may prove attractive to any anthophilous insect. In proof of this it may be stated that insects frequently attempt to visit flowers from which they are excluded. I have seen butterflies standing beneath the perianth of *Iris versicolor* and stealing the honey, without rendering any service in return; an hymenopter, probably an ichneumon fly, was observed, but not caught, examining the center of the flower for nectar, and of course, unsuccessfully; flies are attracted by the bright colors of *Impatiens biflora* to the outside of the calycine sac, and I have often seen *Philanthus solivagus* flying from flower to flower of *Chelone glabra* and examining the lips for nectar, but never entering the corolla.

THE COLORS OF NORTHERN MONOCOTYLEDONOUS FLOWERS.

Orders.	Families.	Yellow.	White.	Red.	Purple.	Blue.	Green or Dull Color.	Total.
Pandanales	Typhaceæ						2	2
	Sparganiaceæ						4	4
Naiadales	Naiadaceæ						42	42
	Scheuchzeriaceæ		1				3	4
	Alismaceæ		19					19
	Vallisneriaceæ		3					3
Graminales	Gramineæ						371	371
	Cyperaceæ						334	334
Arales	Araceæ	1	2				5	8
	Lemnaceæ						11	11
Xyridales	Mayacaceæ		1					1
	Xyridaceæ	6						6
	Eriocaulaceæ						5	5
	Bromeliaceæ	1						1
	Commelinaceæ			1		11		12
	Pontederiaceæ	1	1			2		4
Liliales	Juncaceæ						47	47
	Melanthaceæ	7	10		2		5	24
	Liliaceæ	6	13	11	1	6	1	38
	Convallariaceæ	2	11	1	4		5	23
	Smilaceæ						11	11
	Hæmodoraceæ	1						1
	Amaryllidaceæ	3	3					6
	Dioscoreaceæ	1						1
	Iridaceæ	2		1				17
Scitaminales	Marantaceæ				1	14		1
Orchidales	Burmanniaceæ					1		1
	Orchidaceæ	10	18	8	14		11	61
	Total	41	82	22	22	34	857	1058

LOSS OF THE ECTODERM OF *HYDRA VIRIDIS* IN THE LIGHT OF A PROJECTION MICROSCOPE.

WILLIAM L. TOWER.

WHILE working with a projection microscope in December, 1897, I placed a living *Hydra viridis* in a small stage aquarium and projected its image upon a screen. The response of the hydra to this stimulus was startling.

My apparatus consisted of an alternating current arc-lamp of fifty-two volt, twelve ampere capacity. The light was taken by a pair of four-and-one-half-inch condensers, and was passed by them through an alum cell to remove the heat rays, then through a bi-convex condensing lens, an Abbé condenser, and finally through the object into the objective.

Projected in this manner, an unexpected sight was visible on the screen. The ectodermal cells, either singly or in groups, were seen to leave the animal, float free in the liquid, and gradually sink out of sight, leaving the hydra composed solely of endoderm, and the thin layer of mesodermal tissue. The cells were not distorted in any way, but retained their normal shape, acting as if they had been separated by some delicate and effective disassociation method. This result, and the fact that it could not be due to heat, as will appear later, led to the further investigation of the phenomenon.

The material had been collected in October, and kept in the laboratory, where it had multiplied to a considerable extent. The hydræ were removed one at a time with a pipette, and placed in the stage aquarium ordinarily used for such purposes, where they were left from twelve to eighteen hours, during which time they fully recovered from being handled. They were then carefully placed upon the stage of the projection microscope. By using sufficient care it was possible to bring the animal at once into the field in an unstimulated condition and fully expanded.

In each of the one hundred and twenty-four times a hydra was placed in the field of the microscope it immediately underwent violent contraction, followed by speedy recovery of the elongated form. In four cases a response of this kind was noted in five seconds from the time the hydra was placed in the light. In two cases a period of forty seconds elapsed before any response was noted.

This response was accompanied by the discharge of a number of the nettle cells on the tentacles. In the great majority of cases the loss of the ectodermal cells began about the time when the animal regained its elongated form. Usually all of the ectoderm was lost, but in a few individuals a small number of cells would adhere to the upper part of the animal. In one case the ectoderm was completely lost in one minute, while another required eleven minutes for its removal (see table, also Fig. 1).

TABLE OF RESPONSES OBTAINED.

Total number of individuals, 124.

First response:

Time in seconds,	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*
No. of individ.,	4	71	6	2	1	10	28	2

Lost ectoderm:

Time in minutes,	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
No. of individ.,	1	0	6	10	80	7	1	2	3	13	1

Ectoderm regenerated:

Time in days,	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*
No. of individ.,	1	0	4	7	7	10	20	30	20	12	3	1	0	0
	23	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*	*32*	*33*			
	1	2	1	0	0	0	1	2	0	1	1			

Time lived after second trial:

Time in days,	*3*	*4*	*5*	*6*	*7*	*8*	*9*
No. of individ.,	2	2	10	42	44	14	10

The first response is evidently due to the concentration of light upon the animal. An interesting point about the response to the light stimulus is the grouping of the individuals about two modes (Fig. 2). One set responds quickly, and tends to gather about a mode of ten (seconds). The other set requires

a continued application of the stimulus for a longer time before the response takes place. These latter tend to group themselves about a mode of thirty-five (seconds). Between these two almost no cases were found.

I cannot explain the loss of the ectoderm. It could not be due to heat, for the alum cell effectually cut out that element, as was shown by placing the bulb of a delicate thermometer in

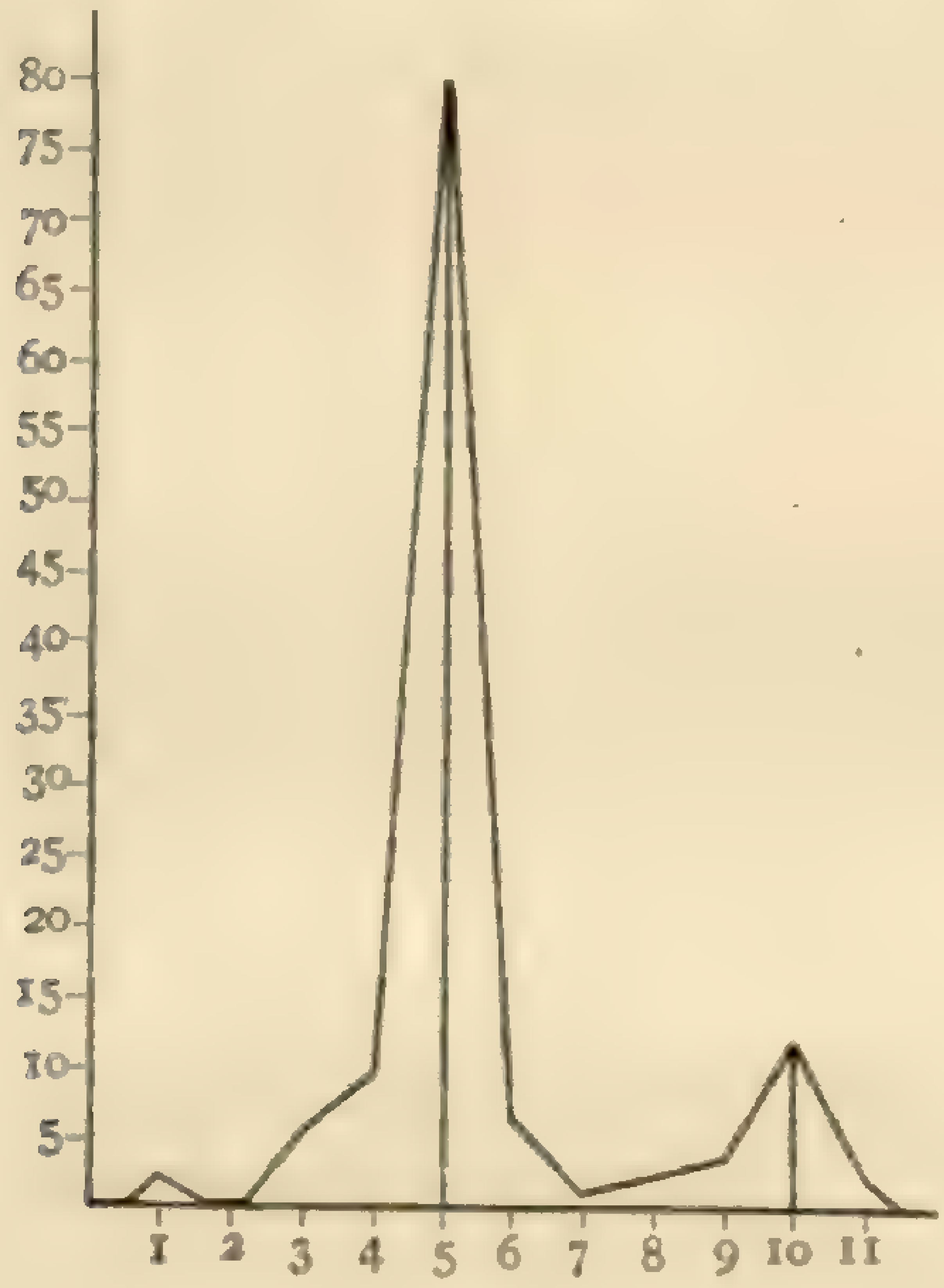


Fig. 1.

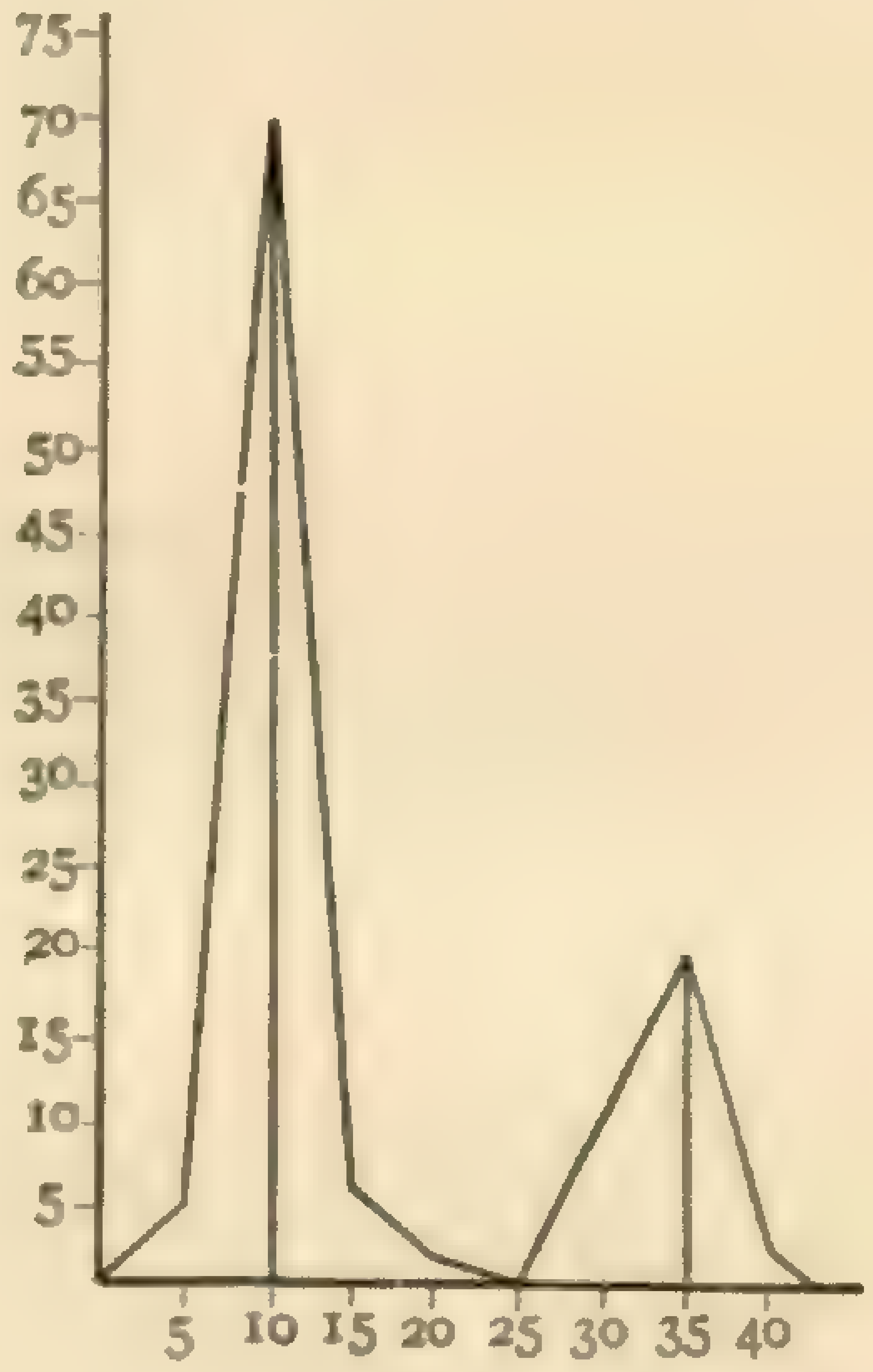


Fig. 2.

Fig. 1. — Curve of the first response. The ordinates represent time (in seconds), and abscissas represent individuals. It is to be noted that the individuals fall in two classes with one mode at ten and the other at thirty-five seconds.

Fig. 2. — Loss of ectoderm. Curve showing the arrangement of the individuals about two modes; one at five, the other at ten (minutes). Ordinates = time in minutes. Abscissas = number of individuals.

the aquarium containing the hydra. There was no change whatever, and the water remained constantly at the temperature of the room, which ranged from 15° to 18° C. It could not have been due to escaped currents of electricity, for insulation was perfect. Neither could it have been the effect of the Roentgen rays, although such are found in the arc-light. The distance of the object from the arc was forty-two inches, and the small amount of those rays generated by the arc-lamp could not have had, it seems, any effect at so great a distance, inasmuch as they were not focused or controlled by optical appliances. This dropping off of the hypodermis, however, resembles in many ways the blistering effects produced upon the skin by Roentgen rays.

No experiments were made to determine what light rays were responsible for this, excepting that it was noted in making a photo-micrograph, using light of long wave-length, that the phenomenon did not occur; but if rays of short wave-length were used, it was impossible to obtain a sharp photograph, owing to the sloughing of the hypodermis. Microscopical examination showed that the sloughing had occurred, and it was also seen on the focusing screen of the camera. Beyond this I did not determine the action of the rays of different wave-lengths, although I believe this phenomenon is in some way related to rays of short wave-length.

After the removal of the ectoderm by this means, the hydra was very unresponsive to stimuli. It remained in an elongated condition even when handled violently. Before twenty-four hours had elapsed it had contracted into an oval mass, with the tentacles almost entirely retracted; but it recovered its normal expanded condition in three or four days.

It is interesting in connection with this to note the regeneration of the ectoderm. Each hydra, after having been subjected to this treatment, was placed in a small bottle and given plenty of fresh water until it recovered. The most rapid recovery took place in nine days, while the slowest required thirty-three. The great majority recovered in from fifteen to seventeen days (see table). I have made no histological study of the regeneration of the ectoderm, but observed it with considerable constancy in the living animals, and found that it appeared first about the oral end.

If a hydra after complete recovery, that is, after complete regeneration of the ectoderm, was again subjected to the same treatment, the second response to light would occur in about the same time as before, and usually fall in the same modal class. This was true also for the loss of the ectoderm. It was noted, however, that some of the individuals that responded quickly to light and to the stimulus that removed the ectoderm in the first trial showed a near approach, or completely conformed to the second modal class in the second trial.

I was not able to obtain a second regeneration. The hydra did not recover at all, but remained as if stupefied, moving only

when chemically stimulated. In three or four days it would be found contracted, and in six or seven days would macerate and entirely disappear.

The case is interesting, and, as far as I know, no similar one has ever been recorded. It is manifestly a case of response to some form of radiant energy, either of light or short wave-length, or of some other form beyond the visible end of the spectrum. It would have been desirable to have carried out histological studies upon this material, but I was unable to do so at the time.

CAMBRIDGE, MASS., Feb. 10, 1899.

EDITORIAL COMMENT.

Keys for the Determination of American Invertebrates. — Beginning with the next issue the *American Naturalist* will publish a series of synoptical tables or keys for the determination of American invertebrates, each key covering one group. Each article will be prefaced by a brief account of the habits and occurrence of the forms under consideration, with hints for collecting, and will be accompanied by simple illustrations where such are necessary to emphasize points of systematic importance. An American bibliography and the best general references will form a part of each contribution. We have long had the valuable *Manual of Vertebrates* of our distinguished co-editor, Professor Jordan, and the *Naturalist* now strives to supplement in a measure this useful work by publishing synopses or keys for the invertebrates, hoping thus gradually to give to Americans an equivalent of the German 'Leunis,' corresponding to which there is nothing in the English language. The task we have set for ourselves is not an easy one. We cannot hope to cover all the invertebrates of North America, as many groups have been but partially studied, which is true particularly of western and Pacific forms. It will be our effort, however, to present to our readers brief synopses of the present state of our knowledge. We invite correction and criticism, and beg our readers to test our keys to their full capacity; and if they will send to us specimens that they cannot place in the keys, we will undertake to determine and return them. Such coöperation will aid us in enlarging and revising the keys for future issue, and help in perfecting the work we have undertaken — a Manual of Invertebrates. Uniformity of treatment can at first hardly be realized, owing to the many sources from which the contributions must come, but we look forward to the accumulation of material sufficient for the publication of at least one homogeneous volume. Eminent specialists have pledged their coöperation; the first of the series, to appear in the July issue, will deal with the fresh-water Bryozoa.

Outdoor Nature Study. — Any one who has witnessed the struggles of the average unprepared school-teacher with "nature study" knows how much in need she is of a friendly guide to take her out of

doors and teach her what nature really is. An attempt to meet this need is to be made during the summer by the Rhode Island College of Agriculture and Mechanic Arts, at Kingston, R. I., where a summer school of nature study will be held from July 5–19, provided forty applicants are enrolled before June 1. The program is rather ambitious for the short time allowed, as it includes physiography, botany, zoölogy, and horticulture. But as the work is to be chiefly in the field, if it is skillfully conducted, no doubt most teachers will be able to get from it considerable instruction and a great deal of inspiration for future work.

Vertebrate Ancestry. — The recent attempt by Roule (C. R., October, 1898) to seek the ancestry of the vertebrates in Actinotrocha, it seems to us, is the most ingenious and the most improbable of any view yet advanced. It demands that the mouth of Actinotrocha becomes the vertebrate neurenteric canal, while the vent forms the vertebrate mouth.

New "American Anthropologist." — It is with genuine pleasure that students of anthropology greet the new *American Anthropologist*, the first number of which appeared in March. The new journal replaces the periodical that appeared under the same name for the last ten years. The change is most welcome and promising. The old *American Anthropologist* served a good purpose. It was the official journal of the Washington Anthropological Society; it became the forum of smaller contributions to anthropology, and it stimulated and preserved many efforts of value, but its scope was too restricted. It was not a fair representative of the science of anthropology in this country, and could not keep up with its advancement. Thus it became evident that either the *American Anthropologist* had to undergo a radical change, or that a new, larger, more representative journal had to be established.

The first practical efforts for the establishing of a new journal of anthropology were due to Dr. Franz Boas, of New York, and Professor Wm. J. McGee, of Washington, who were soon seconded by other anthropologists of prominence. Dr. Boas formulated a definite proposition and brought it before Section H of the American Association for the Advancement of Science, at its winter meeting in Ithaca, in December, 1897. The proposition aimed rather at a metamorphosis of the established journal than at beginning a new periodical, the change taking place with the consent and coöperation of the Washington Anthropological Society. Section H of the Ameri-

can Association supported the proposition, and, following the report of its committee, at the annual meeting of the Association in Boston, in 1898, voted its approval of establishing the new journal. The coöperation of the Washington Anthropological Society was secured, and it was decided to discontinue the old journal and allow the new, more efficient periodical to take its place. By almost common consent of the subscribers, the new journal was to retain the name of the old one.

As to the aims of the new *American Anthropologist*, we cannot do better than quote its editors: "The editors aim to make the journal a medium of communication between students of all branches of anthropology. The contents will embrace (1) high grade papers pertaining to all parts of the domain of anthropology, the technical papers to be limited in number and length; (2) briefer contributions on anthropologic subjects, including discussion and correspondence; (3) reviews of anthropologic literature; (4) a current bibliography of anthropology; and (5) minor notes and news." The purpose of the *American Anthropologist* will be "to disseminate as widely as practicable, for the use of scholars and of students, the results of anthropologic investigations."

The Editorial Board of the new journal is composed of Messrs. Frank Baker, W. H. Holmes, and J. W. Powell, Washington; Franz Boas, New York; Daniel G. Brinton, Philadelphia; F. W. Putnam and Miss Alice C. Fletcher, Cambridge; Geo. A. Dorsey, Chicago; and Geo. M. Dawson, Ottawa, with F. W. Hodge, of Washington, as the managing editor and secretary.

It is evident that the establishing of this new, more efficient journal marks a real progress in American anthropology.

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

Explorations in the Far North. — The volume at hand is a report, by Dr. Russell,[1] of an expedition, under the auspices of the University of Iowa, during the years 1892–94, to the region of the great Canadian lakes. The principal aim of the expedition was to obtain specimens of the larger northern mammals; the author supplemented this with additional investigations in natural history and ethnology of the regions visited.

The work was apparently intended not to be too technical. It is written in a popular vein and contains many interesting incidents of hunt and travel. At the same time the report is interspersed with valuable ethnological and zoölogical data. The ethnological material comprises numerous notes on the natives of Saskatchewan, on the Athabascans, Crees, and Eskimos. The text is accompanied by a map and numerous illustrations.

The book is printed on good paper and makes throughout interesting and instructive reading. HRDLICKA.

West African Studies. — Miss Kingsley's *Studies*[2] includes the narrative of her journey to the west coast, the climate of that region and its effect upon foreigners, the religion of the natives, commerce, and the crown colony system. The book is written in a vivacious and entertaining style, though at times affected and verbose. Its greatest value to the ethnologist lies in its account of the character of the natives, and especially of their religious beliefs. It is to be regretted that Miss Kingsley did not follow the wholesome advice given by Tylor and call religion by its right name. The opinion is advanced that neither Christianity nor Mohammedanism in their pure forms will become the prevailing religion of the West Africans, though they now believe in a Supreme God, and the idea of a man-God, or mediator, appeals to them. Miss Kingsley divides West

[1] Russell, Frank. *Explorations in the Far North.* Davenport. Published by the University of Iowa, 1898. 290 pp., plates and map.

[2] Kingsley, Mary H. *West African Studies.* Macmillan, 1899. xxiv + 639 pp. Illustrations and maps.

African religion into four "schools," *viz.*, the Tshi and Ewe, Calabar, Mpongwe, and the Nkissim or Fjort. The first of these is mainly concerned with the preservation of life, the Mpongwe with the attainment of material prosperity, and the Nkissi with the worship of the mystery of the power of earth — Nkissi-nsi. The geographical distribution of these leading forms is not known. "Sierra Leone and its adjacent districts have not been studied by an ethnologist. We have only scattered information regarding the religion there." The dominant idea in the "Calabar School" is reincarnation, with attendant human sacrifice at the time of burial. The Mpongwe are a negro race with a Bantu language, and the religion "they have elaborated and coördinated is Bantu in thought form." "It has no gods with proper priests. Human beings are here just doing their best to hold their own with the spirit world, getting spirits under their control as far as possible, and dealing with the rest of them diplomatically." Fetishes are everywhere common; in addition to the fetish of the town preserved in a fetish house, "every fetish man or priest has his private fetishes in his own house, one of a bird, stones encased by string, large lumps of cinder from an iron furnace, calabashes, and bundles of sticks tied together with a string. All these are stained with red ochre and rubbed over with eggs." The material objects are not worshiped in themselves but as the things in which the spiritual agencies take up their residence. While this account of the religion of the West Africans is suggestive and entertaining it is by no means monographic.

The interesting chapter upon the "Witch Doctor" is addressed rather to the general reader than to the ethnologist; the conclusion is that the witch doctors who succeed in having people killed for bewitching do more good than harm. "As to their using hypnotism, I suppose they do use something of the sort at times."

Miss Kingsley ascribes the failure of the English in the more unhealthy portions of the tropics to the crown colony system. In West Africa this has resulted in the disorganization of the native society with no compensatory building up. Wars are no longer carried on by the English for the purpose of stamping out slavery, human sacrifice, and the like, but for the sake of conquest. In the dark race have been implanted the strongest feelings of fear and distrust, while the whites in arrogance and ignorance strive to impose their culture upon the subject race without regard for native customs or native needs. Property is of three classes: ancestral, connected with the office of headmanship; family, in which every member has

a certain share; and private, that which is gained by private exertion in addition to that which properly belongs to the first two classes. The general tendency, however, is for all property to become family property. Mother-right prevails, and all forms of property are subject to the same law. "In West Africa there is not one acre of land that does not belong to some one."

In an appendix of 123 pages M. le Compte C. N. de Cardi describes the customs, religion, etc., of the Niger Coast Protectorate. The custom of sacrificing human beings, we are told, has been steadily increasing of late years at Benin City, which has become more and more a holy city among the pagan tribes. He repeats Miss Kingsley's statement that the natives believe in a Supreme Being, but as he is always doing good, the sacrifices are not intended for him, but for a malignant spirit whose thirst for blood is thus appeased. Among the "Brassmen" the feather ordeal is employed for the detection of criminals. The Ju-Ju man thrusts a feather from the under part of a fowl's wing through the tongue of the accused, forcing the quill down from above; if the feather breaks as he draws it out below, the person is guilty. In New Calabar the Ju-Ju priest can "so disguise a person that his own mother would not recognize him," as one of the natives declared, and "that they could cause a tree on the banks of a river to bend its stem and imbibe water through its topmost branches; that they could change themselves into birds and fly away; and, lastly, that they could make themselves invisible before your eyes, and so suddenly that you could not tell when they had done so." Throughout this book we are impressed with the fact that human life is very cheap in West Africa; witchcraft, human sacrifice, cannibalism, murder, and slavery, which alone have taken 4,480,000 souls from this coast during the last two centuries, all contribute toward making West Africa an unpleasant place to live in, even if the climate itself were not a murderous one for both whites and blacks. In the Niger Delta infanticide is quite common; twins and children born with teeth are destroyed, as well as women who become the mothers of more than four children. The work contains many illustrations of interest to the ethnologist. FRANK RUSSELL.

Mythology of the Bella Coola Indians.[1] — The Bella Coola tribe has diminished in numbers, owing to the ravages of disease, until it now contains but a few hundred souls. They speak a dialect of the Salishan language, but are isolated from the main body of

[1] Boas, Franz. *Mem. Am. Mus. Nat. Hist.*, vol. ii, Pt. ii. New York.

the Salish. Their habitat is restricted to two narrow fiords on the central portion of the coast of British Columbia. Through long-continued contact with tribes of other stocks around them they differ from the Southern Salish in both physical appearance and in customs and beliefs.

Dr. Boas refers briefly to the papers hitherto published relating to the Bella Coola, and then presents a general description of the mythology of the tribe. "All the collections which have been made heretofore do not bring out clearly the principal characteristic of the mythology of the Bella Coola. The tribes of the North Pacific coast consider the sun as the most important deity, but at the same time they believe in a great many beings of supernatural power. For this reason their mythology is very unsystematic. The Bella Coola, on the other hand, have developed a peculiar mythology, in which a number of supernatural beings have been coördinated." They believe that there are five worlds, of which this earth is the middle one; above are two heavens, and beneath are two underworlds. The supreme deity is a woman, who lives in the upper heaven and interferes but little with the affairs of men. In the center of the lower heaven stands a house, in which reside the Sun and all the other deities. Our earth is an island floating in the ocean.

"The underworld is inhabited by the ghosts, who are at liberty to return to heaven, whence they may be sent down again to our earth. The ghosts who die a second death sink to the lowest world, from which there is no return." Following the description of the deities and their abodes is an account of the village communities and their traditions; miscellaneous traditions; and, in conclusion, a sketch is offered of the probable lines of development of the mythology of the Bella Coola. The tribe is endogamous and divided into village communities. Six plates accompany the text, depicting the masks used to represent the mythical personages. This memoir must prove to be of value to the general student of ethnology as well as to the specialist.

FRANK RUSSELL.

Anthropological Notes. — Édouard de Sainville has published a brief account of his journey to the mouth of the Mackenzie River, and of his explorations about the Delta, in the *Bulletin of the Société de Géographie de Paris*, T. xix, pp. 290–307. The article is accompanied by a map which locates the harbor discovered by the Count, and which corrects errors in the coast line as now represented on our charts. As de Sainville became intimately acquainted with the natives

during his four years' residence among them, it is to be hoped that he will furnish a more complete account of them than appears in the few pages of this paper. Reports from the missionaries stationed at the trading posts maintained near the head of the Mackenzie Delta, show that the germs of disease are frequently brought into the region in the bales of merchandise, particularly in those of second-hand clothing intended for the Indians. Count de Sainville observed that an epidemic influenza prevailed for two or three weeks after the annual arrival of the steamer with the "outfit" for the post. In order to be certain that this epidemic was due to imported germs and not to sudden changes of temperature that prevail during the month of July when the steamer arrives, he took a sealed zinc case in the month of September, 1891, to a camp about fifteen miles south of the post. A father, mother, and four children were in the camp in perfect health; to these the clothing contained in the case was given. The next morning the mother and two of the children were sneezing, and that evening the symptoms of the mother were more serious. The prompt use of camphor restored them to health within a couple of days.

In the *American Anthropologist* for January, 1899, Miss Alice C. Fletcher gives an account of the ritual used when changing a man's name among the Pawnees. "Why an Indian changes his name after any important achievement, and why he never uses the personal name when addressing another, has not yet been fully explained; therefore, any first-hand information relating to this subject will undoubtedly be welcome to students of anthropology." The ritual was obtained from an aged Pawnee priest whose confidence had been gained by Miss Fletcher and her assistants. Three facts were learned: *First*, a man was permitted to take a name only after the performance of an act indicative of great ability or strength of character, such as prowess, generosity, prudence, courage, or the like; *second*, the name had to be assumed openly, before the people to whom the act it commemorated was known; *third*, it was necessary that it should be announced by a priest in connection with such a ritual as that described. The ritual is given in sixteen lines of the original Pawnee, followed by a literal translation and a free rendering in rhythmic form.

F. R.

GENERAL BIOLOGY.

Effect of Chemical and Physical Agents upon Growth. — The second part of Dr. Davenport's useful *Experimental Morphology*[1] will be welcomed by all students of the theoretical aspects of biology. This volume deals with the effects of external conditions upon growth. The first chapter is devoted to the consideration of the phenomena of normal growth, which is defined as increase in volume. Three factors are recognized — increase of formed substance, of plasma (protoplasm), and of enchylemma. Special emphasis is laid on the importance of the imbibition of water at the period of most rapid growth. Characteristic curves are given showing at first a rapid increase in the rate of growth, which soon reaches a maximum, and then more gradually declines to zero. The final cessation of growth is to be explained by special reasons for each species, and is not due to any general law.

The following chapters treat of the effects upon growth of chemical agents, water, density of the medium, molar agents, gravity, electricity, light, and heat. In each of these the effect of the agent considered is treated first in regard to its effect upon the rate of growth, and then as to its effect upon the direction of growth. The molar agents affecting growth include contact, rough movements, deformation, wounding, and the flow of water. A final chapter is devoted to the effects of certain complex agents upon growth and to general conclusions.

The book has comparatively little to do with theory. It is essentially a very careful and complete résumé of the records of laboratory experiments in the field which it covers. The only experiments that have not been published before are those described on page 365. They were made by Messrs. Frazeur and Sargent in the zoölogical laboratory at Harvard, and their object was to determine the effect of concentration of medium upon the rate of regeneration and fission in certain annelids — a species of Nais and *Dero vaga*. This lack of newness does not lessen the value of the work, however. A glance at the extensive bibliography at the close of each chapter is enough to convince one of the service that the author has performed for biology by bringing together this immense amount of material in so compact and accessible a form.

[1] Davenport, C. B. *Experimental Morphology*, Pt. ii. Effect of Chemical and Physical Agents upon Growth. New York, Macmillan, 1899. pp. 281–509. Illustrated, 8vo.

Persons unfamiliar with the present trend of biological research will be surprised at the large amount of quantitative work exhibited in this record of experiments. Wherever possible, the author has pointed out the adaptive character of the reactions observed in the laboratory. Some readers may be disappointed to find that he has not gone farther than this, and discussed the effects of chemical and physical agents upon the forms of animals and plants in the state of nature. The reason that he has not done this is, doubtless, in the first place, the fact that in nature the effects of these agents upon growth is complicated with their effects upon differentiation, which will be treated of in a later volume; and, in the second place, the lack of material. When the effects of agents under control in the simplified conditions of the laboratory are understood, we may hope to solve the problem of form as presented under the complex conditions of the natural habitat. The work under review is an important step in that direction.

In most cases where the direction of growth is changed in response to stimulation, true tropism, the result is to place the organ in a more favorable position. It is clearly adaptive. The reactions classed under the head of electrotropism, on the other hand, cannot be shown to be adaptive, because organisms never meet with the stimulus employed in the state of nature. Yet the reaction takes place with as much precision as the response to light or heat.

The most interesting of the general conclusions is in regard to the phenomena of "attunement." In several kinds of tropism, as the strength of stimulation is increased, a critical point is reached where the effect changes from positive to negative. This critical point differs in different species, and may be regarded as indicating an optimum intensity to which the organism is attuned. How is this attunement established? Natural selection is rejected and "a cause more consistent with sound physiology" is sought.

It has been shown that the effects of various agents persist after the stimulus has been removed. This "after-effect" seems to show that the agent causes a change in the protoplasm which is more or less permanent. This permits the accumulation of extremely slight effects. When, however, the repeated stimuli are each great, it is not an accumulation, but a diminution of response that is noticed. The organism becomes gradually accustomed to the stimulus and ceases to respond. It is acclimated. The author's hypothesis to explain this is that the chemical change which leads to the response becomes a permanent characteristic of the protoplasm so that no

further response to that particular strength of stimulus is possible. This individual attunement may persist, and may be inherited and thus initiate a racial attunement.

The author does not claim that this is a complete explanation of the facts. It is merely a tentative hypothesis. But it is almost too soon to attempt even an hypothesis, for if we try to compare the critical points of the various kinds of stimuli in their effects upon the rate and the direction of growth, in order to see what relation exists between them and how they are related to adaptive responses of the organism, we find the data often contradictory and always inadequate. For example, if we compare the tables given on page 439, we find that of the seven species mentioned in Table 45, only four are to be found in Table 46. Moreover, the first mentions the organs affected, while the second leaves us in doubt as to whether we are dealing with root or stem. Similar difficulties arise in an attempt to compare the table on page 454 with those on pages 464 and 465. All this goes to show that, in spite of all that has been done, more work is needed, and the author's hypothesis will be of value if it serves no other purpose than to stimulate research from a broad point of view.

We notice few errors and omissions. On page 411, line 4, for *plant* read cylinder. The important work of Martin and Friedenwald[1] on the effect of light upon metabolism in animals has been overlooked. On page 440 a diagram of the spectrum is given, showing an interesting coincidence between the point of maximum retardation of growth and that of no phototropic effect. But this coincidence is not mentioned in the text.

R. P. B.

Variation Statistics.[2] — In this work Duncker provides naturalists with the new tool which the English anthropologists, zoölogists, and mathematicians have developed. Many of the works of the mathematicians, especially the invaluable treatises of Pearson, have been beyond the mathematical training of most biologists. In this paper the results of these treatises are given in a comparatively simple fashion. Great stress — relatively too much in the reviewer's opinion — is laid on the methods of constructing the various types of

[1] Martin, H. N., and Friedenwald, J. Some Observations on the Effect of Light on the Production of Carbondioxide Gas by Frogs, *J. H. U. Studies*, iv, 5, p. 221, 1889.

[2] Duncker, G. Die Methode der Variations-Statistik, *Arch. für Entwickelungsmechanik der Organismen*, Bd. viii, pp. 112–183. Feb. 21, 1899.

curves agreeing with any observed distribution of varying individuals. To solve some of the equations, logarithms, trigonometric functions and gamma functions have to be employed, and it is too much to hope that a large proportion of naturalists can use even these simple methods. Yet naturalists who desire to reach best results from their data must get out their algebras, trigonometries, and logarithmic tables, and brush up on these subjects. Formulas are used very freely, which is no doubt an offense to some. It should be remembered, however, that a formula is only an abbreviated statement of operations, and very useful to any one who knows how the operations indicated are performed. The author gives the various indices of variability. He objects to the use of the coefficient of variability (obtained by dividing the index of variability by the mean) and maintains that the view that we expect high indices of variability where the mean is high is untenable. As evidence for this conclusion he points to the fact that in the four numerical examples given in his paper the index of variability is inversely proportional to the mean. This is, however, absolutely no evidence against the value of the coefficient of variation, since, doubtless, the large characteristic which has a small index of variability is, in comparison with the small character having a large index, relatively even less variable than a comparison of the mere indices would indicate.

Correlation is treated of briefly, and an excellent short method of calculating the coefficient of correlation is given. The calculation of spurious correlation of indices is not given — an important omission; and little is said about multimodal curves, which are frequent in biological statistics.

A bibliography of 111 titles is given (from which Fechner's 1897 work is omitted), and tables of formulas add greatly to the usefulness of the paper.

Altogether the paper is one which every student of statistical biology — *and this ought to include every systematic worker in zoölogy and botany* — should have.

Inheritance of Acquired Qualities.[1] — Conidia of *Aspergillus niger* of common origin are reared (*A*) in Raulin solution; (*B*) in Raulin solution + 6 per cent NaCl for *one* generation; and (*C*) in Raulin solution + 6 per cent NaCl for *two* generations. Then:

[1] Errera, L. Hérédité d'un caractère acquis chez un champignon pluricellulaire, *Bull. Acad. Roy. de Belg.*, 1899, pp. 81–102.

I. In a Raulin solution + 18.4 per cent NaCl:
A, shows no germination;
B, slight germination;
C, general germination.

II. In a Raulin solution + 6 per cent NaCl:
A, produces spores in 5 days;
B, produces spores in 4 days;
C, produces spores in 3¾ days.

III. In a Raulin solution, without additional salts:
A, sporification in 4 days;
B, sporification in 5 days;
C, sporification in 5 days, but slight.

Spores from cultures III, *A*, *B*, and *C*, are sowed in Raulin solution + 18.4 per cent NaCl:

IV. *A′*, after 5 days, no germination;
B′, after 5 days, just visible germination;
C′, after 5 days, clearly visible germination.

Hence (I and II) the Conidia of Aspergillus become adapted to the medium in which their parent is growing, and more adapted after the second generation than after the first.

The adaptation is such that a normal solution is disadvantageous to Conidia adapted to a dense solution.

The adaptation to concentrated medium is not wholly lost after rearing in a normal medium. (IV.) There is a persistence of the adaptation, there is an inheritance of the acquired quality of resistance to concentration.

ZOÖLOGY.

Evans's Birds. — The ninth volume of *The Cambridge Natural History*, comprising the *Birds*, by A. H. Evans,[1] has just come to hand.

Ornithologists have of late years been favored with several general works on the natural history of birds, by competent authors, the main object of which has been to present the results of recent studies of the structure of the various groups composing this class. On the other hand, the usual number of "popular," often inaccurate and

[1] Evans, A. H. *Birds*. The Cambridge Natural History, vol. ix. London, New York, Macmillan, 1899. xvi + 635 pp., 8vo, 144 figs. + 2 polar charts.

gossipy, accounts of the habits of the feathered tribes, without regard to the present status of the *science* of ornithology, appear regularly and find a ready sale. Realizing this, Mr. Evans has set himself a different task in the book before us. In the recent literature he has found no concise general account of the *species* of the birds presented in a popular form, and he consequently planned to give one in the 587 pages of this work. This plan precludes of course any original work, but it is in itself original enough, and daring to a degree. Manifestly a mere enumeration of the species would not do, while even the briefest description of each would more than fill the book. He has consequently been obliged to limit himself "to a short description of the majority of the forms in many of the families, and of the most typical and important of the innumerable species in the large Passerine order." But even with this limitation the task would appear well-nigh impossible. Yet, in going over the book carefully, we have to admit that he has succeeded, and succeeded admirably; for not only has he accomplished the above, but he has given in addition a compressed introduction to avian structure, external and internal; the various groups and divisions are characterized; the habits of the birds are briefly sketched in general terms, mostly under the heads of the families; and the geographical distribution of the species mentioned is often given in considerable detail. Moreover, the fossil birds are treated similarly with the recent forms, and finally 144 woodcuts in the text illustrate the principal types.

Fortunately for Mr. Evans he has been able to accept a thoroughly modern and scientific classification proposed by competent authority. It is but natural that he, as a Cambridge man, should adopt in the main Dr. Gadow's system, and we may add that he might have gone farther and not fared as well. On the other hand, so far as the species and to a great extent also the genera are concerned, he has had the benefit of the now completed series of magnificent volumes constituting the catalogue of birds in the British Museum. Finally he appears to fall back upon the "Strickland Code of Ornithological Nomenclature," the elasticity of which enables those who profess to adhere to it to follow their own ideas, or "common sense," as they are invariably styled. It is thus impossible to quarrel with Mr. Evans where one does not agree with his authorities. He has quoted them, and we have to settle our disputes directly with them.

In judging the size of Mr. Evans's task it must not be forgotten, however, that it is now twenty-five years since the first volume of the bird catalogues of the British Museum was issued, and that he has had

to bring the subject down to date, as exemplified by the "addendum" (p. viii), containing references to forms described during the printing of the *Birds*.

It will be understood that not the least difficult part of the problem has been to introduce the enormous number of species and to present the "dry matter" of their structure, color, and distribution in such a way as not to become monotonous, and to condense the account of the habits sufficiently while yet retaining a readable form. In both respects Mr. Evans has proved himself a master. Where one hardly expects to find room for the mere mention of the names, one is surprised and delighted to find pages brimful of boiled down facts, yet holding one's attention and reading as smoothly as a novel. Mr. Evans has selected for his motto Virgil's *In sicco ludunt fulicæ*, with the equivalent rendition: "Loons disport themselves on dry matters"; but he certainly does not need this humorous apology.

It is plain, however, from what has been said of the plan, that the main value of the book depends on the accuracy of the statements it contains. To verify them all is not the reviewer's task, but in the short time he has had the use of the book he has tested it in many places and many ways, and in every case found it essentially correct. Of course nothing else was expected of Mr. Evans, with his intimate knowledge of the literature and his careful and painstaking method; yet it is pleasing to find that these qualities are paired with a critical skill of no mean order. Moreover, in cases of unusual or uncorroborated statement, Mr. Evans has mostly given his authorities in footnotes. As a matter of fact most of the matter is necessarily second-hand, the responsibility of the author being chiefly confined to the selection, and of course he does not guarantee the accuracy of his informants except in a general way. Thus, on page 313, in speaking of *Sterna longipennis* having "blackish feet," he adds in a footnote that "Mr. Barrett-Hamilton, however, tells the author that the feet are red in life," while as a matter of fact the feet of this species are neither black nor red, but "blackish red" or "dark reddish brown" (Stejn., *Orn. Expl. Kamtsch.*, p. 85).

Most of the illustrations are by Mr. G. C. Lodge, apparently made specially for this book. The majority must be pronounced both accurate and characteristic, while some are admirable in every respect. The sober attitudes of the bird and the total absence of "scenery" are highly commendable. The much admired woodcuts from the *Natural History of Selborne* may be more artistic, but a comparison with those which have been borrowed from the latter work,

for instance, the wryneck and the nuthatch, shows how vastly superior the modern figures are as zoölogical illustrations. In the limited space of this volume much room could not be spared for pictures, but figures are given of representatives of most of the important groups. It may be disputed, however, whether the selection of species illustrated is the best one which could have been made for a book of this scope. Over one-third of the species figured are English, some of them the most common and best known birds with which every reader of the book is thoroughly familiar. It can hardly be doubted that a figure of Podoces would have been more valuable than that of the raven, or that Pyrrhuloxia would have been preferable to the house sparrow. However, the author is probably not to blame in the matter. Editors and publishers usually have a way of interfering with his best intentions — concerning the illustrations.

The author expresses the hope that the work may be of real use, not only to the tyro in ornithology, but also to the traveler or resident in foreign parts interested in the subject, who, without time or opportunity for referring to the works of specialists, may yet need the aid of a concise account of the species likely to cross his path. There certainly was a need of such a book, and the present one meets it as well as it can be done in the limited space. From the treatment of the various groups I may add that the class of people most likely to derive the greatest benefit from the book is the traveling sportsman with an eye open for other birds and game in the strictest sense. But even the working naturalist, let alone the tyro, will find it an inexhaustible mine of solid ornithological facts.

LEONHARD STEJNEGER.

Blind-Fishes of the Caves. — In *Science* for February 24, Dr. Carl H. Eigenmann describes a new genus of blind-fishes, which he finds a remarkable case of the convergence of characters. The species, first obtained by Mr. Garman from the caves of Missouri, was identified by him with *Typhlichthys subterraneus*, a blind species inhabiting the caves of the Ohio Valley. The two forms are almost identical superficially, but Dr. Eigenmann finds in fresh material abundant evidence that they are descended from distinct forms. The genus Chologaster, of the swamps of the South, is regarded as evidently the ancestor of Typhlichthys, but the new form from Missouri, called by Eigenmann *Troglichthys rosæ*, must have had a different ancestry in the same family. "Judging from the degree of degeneration of the eye, Troglichthys has lived in caves and done

without the use of its eyes longer than any other known vertebrate." "More than this, *T. rosæ* is probably the oldest resident in the region it inhabits."

The remaining genus of blind-fish, Amblyopsis, has ventral fins, and must therefore have had a distinct ancestry, as in the three other genera ventral fins are absent. All this points to an earlier time when the Amblyopsidæ were represented in the lowlands of the South by at least three distinct-eyed genera, but one of which, Chologaster, is now extant. Eigenmann regards Troglichthys as "in many ways the most interesting member of the North American fauna."

D. S. J.

Trout of the Olympic Mountains. — Some three years ago Rear-Admiral L. A. Beardslee brought from Crescent Lake, in the Olympic Mountains, two new forms or species, or subspecies, of trout, called by Dr. Jordan *Salmo crescentis* and *Salmo beardsleei.*

These forms are products of isolation and land-locking, the probable ancestor of both being the Steelhead trout, *Salmo gairdneri.* Lately Dr. Daniel G. Elliot, of the Field Columbian Museum, has made an extensive survey of these and other lakes in the same mountains. Other land-locked forms, also differentiated by isolation, are found, and these have been described in detail by Dr. Seth E. Meek in the publications of the Field Columbian Museum.

Dr. Meek recognizes *Salmo bathoiceter*, the long-headed trout from Lake Crescent; *Salmo clarki jordani*, the spotted trout of Lake Southerland; and *Salmo clarki declivifrons*, the salmon trout of Lake Southerland.

The question of the ultimate rank as species, subspecies, etc., of our western trout is one of the most difficult in taxonomy. Fortunately, the question is one of nomenclature only, for the real origin and relation of the various forms admit in no case of serious question.

In the same paper Dr. Meek describes new garter snakes from the same region as *Thamnophis leptocephalus olympia* and *Thamnophis rubrostriatus.*

D. S. J.

Fishes of the Revillagigedos. — In the *Report of the U. S. Fish Commission* for 1898, Dr. Jordan and Mr. R. C. McGregor give a list of the fishes taken by Mr. McGregor on the cruise of the *Wahlberg* about the Revillagigedos, off the west coast of Mexico.

The interesting feature of the collection is the large number of

typically East Indian forms obtained. The list contains sixteen species not found along the mainland of Mexico, but which are nearly or quite identical with East Indian forms. This shows the comparative continuity of the Polynesian fish fauna. Six new species are obtained, *Myrichthys pantostigmuis*, *Zalocys stilbe*, *Apogon atricandus*, *Forcipiger flavissimus*, *Cantherines carolæ*, and *Azurina hirando*. All except the Apogon are figured; Zalocys, Forcipiger, and Azurina are new genera. Most of the species recorded were obtained by the use of dynamite among the rocks.

We regret to learn from the daily press that, in a second expedition in the same region, Mr. McGregor, in his schooner, the *Stella Erland*, has been wrecked on the coast of Lower California, all his valuable material being lost.

D. S. J.

The Miller's Thumb of Europe. — In the *Proceedings of the Swedish Academy*, Mr. Lars Gabriel Andersson takes up the vexed question of the relation of species in the genus Cottus, or Miller's Thumb, as shown in the waters of Europe.

This genus, in common with most others of relatively recent origin, exhibits surprising variations as represented in different waters; while, on the other hand, the characters which separate species are slight and sometimes unstable.

After a very detailed comparison Mr. Andersson concludes that *Cottus pœcilopus*, of the Carpathian Mountains, is a species distinct from the common *Cottus gobio*. Our own experience with the American species of the same genus tends to confirm his conclusions.

D. S. J.

Fishes of Santa Catalina Island. — Dr. Charles H. Gilbert reports, in the *Report of the U. S. Fish Commission* for 1898, on the Fishes obtained by the steamer *Albatross* in the vicinity of Santa Catalina Island and Monterey Bay. A large number of deep-sea forms were taken, two of them, *Radulinus boleoides* and *Averruncus sterletus*, being new to science. These species are figured in the report.

D. S. J.

Helminthological Studies of Kowalewski. — A recent number of the helminthological studies of M. Kowalewski[1] presents some

[1] Études helminthologiques. V. Contribution à l'étude de quelques Trématodes, *Bull. Acad. Sci.* Cracovie, Fév. 1898. French résumé accompanying the Czeckish original, with 2 plates.

important observations. *Echinostoma spathulatum*, discovered in the intestine of *Botaurus minutus* by Bremser, and never reported since the original description of Rudolphi, was found in the same host. Its peculiar features as described by the author render it worthy of generic rank. The most striking point is the pair of retractile papillæ, armed with spines, which are found on the mid-ventral line in the posterior third of the body and serve as organs of fixation. A branch from each lateral excretory canal penetrates into each papilla and terminates there in a sac, producing a mechanism which recalls the Echinoderm ambulacrum. Cutaneous glands give rise to appearances like the tactile papillæ of Blochmann and Bettendorf; these are elevations with apparent openings in the apex and a minute duct, the connection of which with the glands was not demonstrated. Noteworthy is further the occurrence of cilia on the epithelium of the intestine.

The author then discusses three new forms of the genus Opisthorchis, in one of which the excretory pore has an unusual location, on the mid-ventral line just behind the ovary. The tendency in this genus to dextrosinistral inversion of organs, or, as Kowalewski calls it, to sexual amphitypy, which makes some individuals the mirror image of the usual type in the species, is treated at length and from evidence submitted shown to be present in half of the known species. The diagnosis of the genus is amended and its subdivisions outlined.

For the interesting *Bilharzia polonica*, discovered by Kowalewski in 1895, a large number of hosts is now reported, species of Anas and related genera. Usually the parasite is found in the blood, but occasionally in the gall bladder; its nourishment, as the author maintains, consists primarily of blood plasma and less frequently of erythrocytes. In addition to structural details previously reported, mention is here made of special dermal organs of the male, which in appearance are not unlike tactile papillæ or the cutaneous glands referred to above. These exist separately or in groups on the ventral surface, including the suckers, on the dorsum of the neck, and on the posterior margins of the body. Strings of granules from the apex connect with granular masses in the gynecophoric canal, suggesting the discharged secretion of glands; yet these masses may be of external origin. The Czeckish original is illustrated by two fine plates. However much one may admire the loyalty of the author, it is yet a matter of regret that one's knowledge of the work must be gained from a brief French résumé, because the riches of the original article are buried in such an inaccessible language. H. B. W.

Blood Spots in Hens' Eggs. — Every one is familiar with the fact that flecks of blood are occasionally seen on the surface of the yellow of a perfectly fresh hen's egg. It is evident that these flecks are derived from some maternal structure and are not a product of the development of the egg, as they are present before incubation begins and are outside the embryonic area. Professor Mitrophanow,[1] upon investigating the nature of these flecks, has arrived at some interesting conclusions regarding the origin of the egg-membranes of birds.

According to the classical description of Foster and Balfour, the yellow of the egg is enclosed by a single "vitelline" membrane, the exact source of which, however, whether from the egg itself or from follicular cells surrounding it in the ovary, is unknown.

Most recent investigators assign to it a follicular origin. Mitrophanow finds that it is really a double membrane whose parts are of different origin. Its double nature is demonstrated by the occurrence of the blood clots previously referred to not, as one might expect, on the outside of the vitelline membrane, or on its inner surface, but between the two laminæ of which it is composed.

Mitrophanow states reasons for believing that the blood clot can only have been deposited on the egg after it had left the follicle. If so, the outer lamina must have been formed in the upper part of the oviduct and accordingly must represent, not an ovarian product, but an accessory envelope. The delicate inner lamina Mitrophanow regards as a true vitelline membrane formed by the egg-cell itself.

Origin of the Fauna of the Central African Lakes. — J. E. S. Moore has published[2] very interesting researches on the fresh-water fauna of the African lakes, chiefly Lake Tanganyika. He divides the fauna into two constituents: (1) types which are represented generally in the African fresh-water bodies; (2) types which are found nowhere else in fresh water, but have relations in the ocean (halolimnic organisms).

To the latter class belong the Medusæ, discovered by Boehm in 1883, numerous mollusks, both of the shore and of deeper water, and further two species of shrimps and a deep-water crab.[3]

The mollusks are allied, in many cases, not to a single marine form,

[1] *Bibliographie Anatomique*, Tome vi, Fasc. 2, pp. 69–84.

[2] *Nature*, vol. 58, 1898, p. 404.

[3] These Crustaceans may prove to belong to the first class (generally distributed fresh-water animals), since such forms, belonging to the shrimp genus Caridina and the crab family Potamonidæ, are found all over the African continent. — *Rev.*

but to several; and it seems as if they represent connecting links between these forms like ancestral types. There seem to exist, in the Tanganyika, numerous unknown species, chiefly in greater depths, but the author had no facilities to make a collection of the fauna of these depths.

The halolimnic fauna of the Tanganyika, as a whole, has a striking Jurassic character. This fauna is positively wanting in the Lakes Nyassa, Meru, and Bangweolo, and — according to Gregory's collections — in the Lakes Naiwasha, Elineteita, Baringo, and — according to Donaldson Smith's and Cavendish's collections — in Lake Rudolf. Moore is of the opinion that the former connection of the Tanganyika with the sea was in a northerly direction, through the Central African depression that is marked by the Lakes Albert and Albert-Edward to the Red Sea. Accordingly, we are to look for the same ancient fauna in these latter lakes, although their fauna is at present unknown.

It may be that this body of sea water in Central Africa continued to exist into Tertiary times, since we have some evidence — as the author points out — of the presence of marine Tertiary deposits west of the Victoria lake, which seem to extend southward to the neighborhood of the Lake Nyassa. A. E. O.

Swiss Rotifers.[1] — The appearance of the second part completes Dr. Weber's superbly illustrated monograph of the Rotifera of the Léman. This paper is by far the most complete account of this group which has appeared since the publication of Hudson and Gosse's *Manual.* In all, 127 species are described and figured with care. With commendable moderation Dr. Weber has refrained from describing any new species, but has devoted his attention to elaborate descriptions of the forms he has found and to an elucidation of their synonymy. The result is a courageous reduction in the number of species, as is attested by the fact that no less than 292 names appear as synonyms in the index which concludes the final paper. The genus Brachionus has been a fruitful field for the species maker, and it is here that our author has done most execution. This genus includes many extremely variable forms, and the question of specific limits here is a most difficult one to solve. It may be that the statistical study of the group will throw some light upon the problem. The desirability of some designation for the many variants is

[1] Weber, E. F. Faune rotatorienne du bassin du Léman, 2me partie. Ploima et Scirtopoda. *Rev. Suisse de Zoöl,* T. v, pp. 355–785, Pls. 16–25. 1898.

evident. Abundant biological data are included in the paper. Dr. Weber proposes a new solution for the Plœsoma enigma, restoring Ehrenberg's *P. lynceum* and recognizing Herrick's *P. lenticulare.*

C. A. K.

Trematode Anatomy.[1] — Kowalewski has given an extended account of the anatomy of certain avian trematodes. He describes a number of papillæ upon the ventral surface of *Echinostomum spathulatum* Rud., each traversed by a canal with granular contents. These structures are interpreted as the outlets of glands found in the adjacent parenchyma, though a direct connection of the two was not established. Similar organs were also observed on the ventral surface, on the suckers, on the dorsal side of the neck, and along the posterior margins of *Bilharzia polonica* M. Kow. These "openings of the cutaneous glands" resemble very much the structures found by Nickerson upon corresponding regions of *Stichocotyle nephropis*, and interpreted by him as cutaneous sense organs on account of their connection with ganglion cells in the parenchyma. The occurrence of sexual amphitypes in a number of species of the trematode genus Opisthorchis is also noted by the author. In parasites from the same host individual the two types of sexual asymmetry occur in about equal numbers.

C. A. K.

The Corpus Luteum in the Pig and Man[2] has been the subject of careful study by J. G. Clark. The origin of this structure has been a matter of long-standing dispute, some investigators maintaining that it arose from the connective tissue investment of the egg-follicle, and others that it came from the follicular epithelium. Clark's observations are strongly in favor of its connective tissue origin. Cessation of ovulation is shown to be not due to the disappearance of egg-follicles, but to a densification of the ovarian stroma, whereby the peripheral circulation of the ovary is so interfered with that the complete formation of the follicles is hindered.

The Albatross Brachyura. — Miss Mary J. Rathbun describes (*Proc. U. S. Nat. Mus.*, XXI, 1898) the brachyurous Crustacea collected by the fish commission steamer *Albatross* during a voyage

[1] Kowalewski, M. Studya Helmintologiczne, V, *Rozprawy Wydz. mat. przyr.*, T. xxxv, 61 pp., Tab. I, II, 1898.

[2] Clark, J. G. The Origin, Growth, and Fate of the Corpus Luteum as observed in the Ovary of the Pig and Man, *The Johns Hopkins Hospital Reports*, vol. vii (1898), No. 4, pp. 181–202, 2 pls.

from Norfolk, Va., to San Francisco. In all there are 151 species, of which 31 are regarded as new. Ectæsthesius, allied to Quadrella, Lipæsthesius, Ovalipes, a new name for Platyonichus, and Tetrias, allied to Pinnixa, are the only new genera proposed. We notice the substitution of Uca for Gelasimus.

Zoölogical Notes. — The life history, habits, etc., of the tree toad, *Hyla arborea*, are exhaustively treated by H. Fischer Sigwart in *Vierteljahrschr. Naturf. Gesell. Zürich*, XXXIV, 4, 1898. The observations cover a period of about fifteen years, and he gives the dates of earliest appearance in spring, order of appearance and different organs during development and metamorphosis, color adaptation, variations, etc. One table shows by curves the relation of the loudness or quantity of the frog's song to the condition of the weather — the better the weather the louder the song.

Acalephs of the Fiji Islands are shown by Alexander Agassiz and A. G. Mayer (*Bull. Mus. Comp. Zoöl.*, XXXII, 9, 1899) to have a remarkable affinity to the forms from the West Indies. Thirty-eight species were taken, representing thirty-six genera, and with the exception of two rhizostomes all the genera are represented by Atlantic species, and in six cases specific differences could not be established between Atlantic and Pacific forms.

Ten new species of deep-sea Madreporaria are described by Major Alcock in his report on the collections of the Indian Survey steamer *Investigator*. The author points out many intimate affinities with the forms from medium depths of the North Atlantic, suggesting a sea connection in the past between the Atlantic and Indian Oceans, probably by way of the Mediterranean.

The classification of the different methods of monogenesis studied by Torrey (*Proc. Cal. Acad. Sci.*, Series 3, I, 345, 1898) in *Metridium fimbriatum*, occurring in San Francisco Bay, is as follows:

I. Longitudinal fission.
  a, equal.
  b, unequal.
    oral — aboral.
    aboral — oral.
II. Basal fragmentation.
III. Budding.
  a, pedal.
  b, œsophageal.

The paper also contains numerical data as to the relative frequency of each of these methods, and the author promises more in the future.

The circulatory system of lungless salamanders is compared with that of salamanders having lungs by Bethge (*Zeitsch. Wiss. Zool.*, LXIII, 680, 1898), who discusses the question of the seat of respiration in the lungless forms. He reaches the conclusion that the mouth, pharyngeal cavity, and integument participate in respiration to an essential extent. He thus is at variance with Marcacci and Camerano, who believe that cutaneous respiration is of little consequence.

The "cellules musculo-glandulaires" of the body wall of Owenia are reëxamined by Ogneff (*Biol. Centralb.*, XIX, February, 1899), who concludes that the structures described by Gilson do not exist. The peritoneal lining of the body cavity is closely adherent to the muscles of the body wall, but the elements do not differ from those in allied forms.

The endothelium of the heart in bony fishes, according to the recent studies of B. Nöldeki (*Zeitsch. Wiss. Zool.*, LXV, 1889), is, at least in part, of entodermal origin, but it is impossible to decide whether it all has that origin.

The eyes of annelids form the subject of the fifth part of R. Hesse's paper upon the organs for the recognition of light in the lower vertebrates (*Zeitsch. Wiss. Zool.*, LXV, 1899). Structural details of a large number of forms, as well as of physiological observations, are given.

New cestodes are described by F. Zschokke (*Zeitsch. Wiss. Zool.*, LXV, 1899) from various marsupials. The paper contains a revision of the species of Beortia and Linstowia *n. g.*

An interesting report on the "Extent and Condition of the Alewife Fisheries of the United States in 1896" has been prepared by H. M. Smith, and published in the *Report of the United States Fish Commission* for 1898. Notwithstanding the increase of catch from about 45,000,000 pounds in 1880 to about 62,000,000 pounds in 1896, the values of the catches have decreased; that of 1880 was placed at $526,000, while the catch of 1896, though one-third as large again, was worth only a little over $459,000.

Number 1 of Volume IX of the *Journal of Comparative Neurology* contains, besides the usual literary notices, the following articles:

"Observations on the Innervation of the Intracranial Vessels," by G. C. Huber; "Observations on the Blood Capillaries in the Cerebellar Cortex of Normal, Young, Adult, Domestic Cats," by F. S. Aby; "An Anomaly in the Internal Course of the Trochlear Nerve," by R. Weil; "Critical Review of Recent Publications of Bethe and Nissl," by A. Meyer; and "Report of the Association of American Anatomists," by D. S. Lamb.

We learn from *Natural Science* that Dr. Gregg Wilson points out that the lung of Ceratodus arises in the two-months-old larva as a mid-ventral diverticulum, and that the development of the pronephros is strikingly like that of urodeles.

The classification of the Coccidiidæ is treated by Louis Leger (*Am. Mus. d'Hist. Nat. Marseille*, Série 2, Bull. I, 71, 1898), who divides this family of the Sporozoa into three tribes, — Disporocysts, Tetrasporocysts, and Polysporocysts, — according to the number of spores in a cyst. Analyses of all known species are given, and also a synoptical table of genera. A number of new or little known species are minutely described and figured; all of them from arthropods, and most of them from myriapods.

The life and work of Fr. Redi, famed equally as a student of letters and of science, are the subject of a recent sketch (*Arch. Par.*, I, 3, 420, 1898). A facsimile of a handsome copperplate portrait and of a medallion, both from the collection of Professor Blanchard, accompany the article. It is rather startling to read in the bibliography of observations on parasites, and in the next sentence to see listed sonnets and dithyrambics!

Dr. H. Wallengren has published in the *Biologisches Centralblatt* an account of the conjugation of *Epistylis simulans*. He finds that the microgonidium is not wholly absorbed by the macrogonidium, the entoplasm and the nuclei alone being retained, while the shrunken ectoplasm is rejected.

The Palolo worm has been carefully studied from the taxonomic standpoint by E. Ehlers (*Göttingen Nachrichten*, math.-phys. Kl., IV, 1898). He identifies it as *Eunice viridis* Gr., and finds the formation of the palolo to be an instance of epitoke, the first observed in this family. The epitokous portions are pelagic and constitute the major part of the worm, only 250 somites out of 544, *e.g.*, being atokous. The paper includes a full discussion of the structure of both parts.

A new Bothriocephalid genus, Scyphocephalus, parasitic in Varanus, has been described by E. Riggenbach (*Zool. Jahrb.*, Syst., XII, 145, 1899). It is characterized by a deep, cup-shaped rostellum, which, however, is not primary, as in Cyathocephalus, but secondary, as shown by the long narrow grooves on the external surface, which are the reduced lateral bothria characteristic of the family. Otherwise the new genus is a true Bothriocephalid.

Tetracotyle perca fluviatilis is found by Piana (*Atti. Soc. Ital. Sci. Nat.*, XXXVII, 1898) to be present in 90–95 per cent of the fish in Varese and other Italian lakes, while in some adjacent bodies of water it was lacking. The author looks upon the species as the cause of fish epidemics there.

In Ligula, M. Lühe calls attention (*Centralb. Bakt.*, Abt. I, XXII, 7, 280, 1898) to the existence of marked external segmentation at the anterior end, very similar to that of other cestodes, though the posterior two-thirds is entirely smooth. Strangely, however, the internal structure does not correspond to the segmentation. As the larva is uniformly smooth, the segmentation of the adult must be developed in the intestine of the definite host. It may be interpreted as rudimentary, and points to the degeneration of Ligula from jointed Dibothrian ancestors that have secondarily lost their segmentation.

A statistical report on the "Nematodes Parasitic in Birds," by W. Volz (*Rev. Suisse Zool.*, VI, 1, 189, 1899), shows that hawks, fowls, and crows are most infected both in number of species and of individual parasites. Among the parasites, *Heterakis vesicularis* was the most common, occurring in nine out of twenty-three hosts examined, and *Trichosoma resectum* was found in six hosts. Only two hosts harbored as many as five species each, while the majority of both hosts and parasites manifest individual association.

Two new tapeworms of the domestic fowl from Brazil are described by Magalhâes (*Arch. Par.*, I, 3, 442, 1898), *Davainea oligophora*, a minute form only 3 mm. long, and *D. carioca*.

An intermediate host of *Gigantorhynchus moniliformis* has been found by Magalhâes (*Arch. Par.*, I, 3, 361, 1898) in *Periplaneta americana*. Some interesting observations on the larva of the parasite are recorded in the same article.

BOTANY.

Campbell's Evolution of Plants.[1] — In publishing his lectures on the evolution of plants, delivered at Stanford University, Dr. Campbell has done a good service not only to students of botany but also to a wide circle of readers interested in general biological problems. The book will prove enjoyable reading to persons with no more knowledge of the technicalities of botany than many high schools now afford. Teachers have long desired such a book for use with advanced pupils. At the same time it will be welcome to botanists as a broad, clear statement of the main facts of plant development and their interpretation from the most modern point of view.

After an introductory chapter, followed by one on "The Conditions of Plant Life," the author discusses in nine chapters the morphology, ontogeny, and phylogeny of the principal types of the vegetable kingdom, and finally, in three chapters, gives a rapid survey of "Geological and Geographical Distribution," the interrelations of "Animals and Plants," and the "Influence of Environment." Each chapter and the book as a whole concludes with a helpful "Summary."

The truly scientific spirit of these lectures cannot fail to exert a wholesome influence upon the students who read them. We find throughout the clearest distinction made between what is actually known and what may be more or less probable, and in weighing probabilities rival views are treated with perfect fairness. Due caution and entire frankness are most happily combined with ample freedom of the "scientific imagination."

One always feels entire confidence that Dr. Campbell's statements are not only trustworthy but up to date. In this case the impression is of a wide range of facts and ideas presented as nearly as possible in their true perspective.

FREDERICK LEROY SARGENT.

A Recent Work on Bryophytes.[2] — The first part of the second volume of Goebel's important work on the organography of plants is now before us and well maintains the high standard set by the first volume, which has already been reviewed in the *Naturalist*. The

[1] Campbell, D. H. *Lectures on the Evolution of Plants.* 12mo, viii + 319 pp., 60 figs. New York, The Macmillan Company, 1899.

[2] Goebel, K. *Organographie der Pflanzen*, Zweiter Theil, Heft 1. Jena, 1898.

second part is concerned with special organography, and the part just published deals exclusively with the Musciniæ. Goebel's extensive studies on these plants make this a most important contribution to our knowledge of the bryophytes.

The structure and development of the different organs are fully treated, but especial attention is devoted to the many adaptations to their environment exhibited by the mosses and liverworts. No botanist has done more to increase our knowledge in this direction, and the present work includes much extremely valuable and interesting matter, a good deal of which is now published for the first time.

The development of the archegonium and antheridium is first discussed, and the various devices for protecting these and the significance of their peculiar position in certain forms are treated at length. The dehiscence of the antheridium is fully described — more so than we can recall elsewhere. The most notable point in connection with the archegonium is the confirmation of the views of Janazewski and Kühn in regard to the apical growth in the archegonium of the Musci, which had been disputed by Gayet.

The various modifications of the Gametophyte in the lower Hepaticæ are described at length, and some very interesting figures are shown, especially those relating to certain tropical types like Symphyogyna and some of its allies.

The different types of gemmæ and tubers found among the liverworts are fully treated. Genuine tubers, which formerly were supposed to be absent from the Hepaticæ, are now known in several genera, including species of Anthoceros, Geothallus, and Fossombronia. The recent discovery of these in a number of liverworts from California and South America indicates that these structures probably occur in a good many species of dry regions. Descriptions and numerous figures of the contrivances for storing water, such as the sac-like organs in the leaves of many tropical Jungermanniaceæ, are given. As might be expected from the careful study of these which the author has made before, the subject is given very thorough treatment.

The various types of sporophyte found among the Hepaticæ are described and figured, but this section of the work does not include much that is new.

As might be expected, the Musci are given less space than the much more generalized and varied Hepaticæ. The more aberrant types, like Schistostega, Sphagnum, and Buxbaumia, are considered somewhat at length. The latter Goebel is still inclined to consider

as a primitive type, although many botanists will be inclined to consider it as a degenerate rather than as a primitive form.

Of the different types of sporogonium among the Musci the peculiar genus Nanomitrium is interesting as showing very marked similarity in the arrangement of its parts to that of the typical liverworts. In this moss most of the endothecium appears to be composed of sporogenous tissue. Whether this genus, and the similar Archidium, are really primitive types, as Leitget supposed, or are related to the typical Bryineæ, remains to be seen.

The book is fully illustrated and includes many new figures. It is certainly a most important contribution to the literature of the archegoniate plants.

D. H. C.

Aldehyde in Leaves.[1] — The formation of an insoluble "hydrazone" on the addition of metanitrobenzohydrazide to a solution of an aldehyde was taken as a means of the quantitative estimation of the latter substance in green leaves. Previously it has been shown by qualitative tests that a "leaf aldehyde" (Blätteraldehyd) is found in many plants. The quantity present seems to vary within wide limits; the conditions influencing its formation are not understood. From the experiments it appears that leaves kept in continued darkness show a decrease in the amount of aldehyde present, but by no means all of it disappears under such conditions. The bearing of this fact on the suggestions that some form of aldehyde is the first product of photosynthesis are, however, not distinct at present. But while nothing has been shown which proves that such a substance may be the initial carbohydrate formed, it is a matter of interest that the aldehyde can be utilized by the plant as a food substance, and such certainly seems to be the case. It would be of especial value, however, to know something of the relation which exists between the disappearance of starch in the absence of light and the partial use of the aldehyde under similar conditions. One might then be able to conclude whether it is due to the exhaustion of other reserve material that the plant is perforce necessitated to utilize the aldehyde, or whether it exercises any selective power in this regard. The writers do not maintain that the aldehyde is to be regarded as the first assimilation product, — in fact they directly state that it is to be regarded as a by-product; but it is hard to agree with them that had

[1] Reinke, J., and Braunmüller, E. Untersuchungen über den Einfluss des Lichtes auf den Gehalt der grünen Blätter an Aldehyd, *Rev. d. deut. Bot. Gesel.*, Bd. xvii, Heft 1, p. 7.

a complete disappearance of this substance been shown by the experiments, conclusive proof would then have been afforded of the primary nature of the aldehyde.

H. M. R.

Light and the Respiration of Fungi.[1] — By a series of carefully arranged experiments, chiefly with *Aspergillus glaucus* and Penicillium, it is shown that the action of light increases (*circa* 10 per cent) the respiration of these fungi, and that this increase is independent of the food supply and of the morphological condition of the culture. As the author says, this increase, though not great, is quite contrary to what our knowledge of these forms would lead us to expect. He refrains from drawing any conclusions from the present data, evidently purposing to pursue the matter further. The results recorded are noteworthy and, if supported by further ones, are of considerable importance.

H. M. R.

Spore Development in the Hemiasceæ.[2] — Two forms of this heterogeneous group are considered in detail as to their spore development. These are Ascoidea and Protomyces. In the former it appears that the spores when ripe lie in a mass of protoplasm analogous to the condition generally found among the Ascomycetes, but the multinucleate condition of the ascus and the behavior of these contained nuclei do not seem to correspond to the observations recorded in the late researches on this last-named group. In Protomyces, on the other hand, the spores do not lie imbedded in a mass of unused protoplasm, but are free within the remnant of the protoplasmic sac which still adheres to the wall of the sporangium. This condition the author regards as more nearly akin to that found in the Phycomycetes. The result of the observations seems to show that these two members of the Hemiasci, aside from their radical dissimilarity in other ways, are not closely related in the matter of spore formation. This it will be noticed does not agree with the arrangement of these forms adopted by Brefeld, but to the average observer who has seen Protomyces, points of similarity of that form with the phycomycetous fungi are not surprising.

H. M. R.

A New Work on Lichens. — Lieferung 180 of *Die natürlichen Pflanzenfamilien* forms the first portion of Fünfstück's account of the

[1] Kolbswitz, R. Ueber den Einfluss des Lichtes auf die Athmung der niederen Pilze, *Prings. Jahrb.*, Bd. xxxiii, Heft 1, p. 123, 1898.

[2] Canna, M. L. Popta. Beiträge zur Kenntniss der Hemiasci, *Flora*, Bd. lxxxvi, Heft 1, p. 1, 1899.

Lichenes. From this a few general statements are culled which may be of interest to non-lichenologists. The literature of lichens is very extensive, that here cited covering three closely printed pages. With very few exceptions lichens are of slow growth and long life, several decades being required by some alpine sorts to reach maturity and fructification. The greater number occur on rocks, but many are found on tree trunks, dead wood, or on the earth. Only a few sorts grow under water (Verrucaria sp.). It may be assumed that nearly every one knows that lichens are symbiotic growths. It is now just thirty years since the publication of Schwendener's memorable paper, and the matter was fought over and settled in the seventies. In different lichens the relation between the fungus and the alga is very different. In Physma, Arnoldia, and many other genera the algal cells are destroyed by the fungus, haustoria being sent through the algal membrane into the plasma. In other lichens, such as Micarea, Synalissa, the haustoria bore through the algal membrane but do not penetrate into the plasma. As a rule the algal cell is entered by only one haustorium. Finally, in many lichens, *e.g.*, those with Protococcus gonidia, the relation of the two components is only one of intimate contact, the fungus causing no visible change either in the membrane or in the contents of the algal cells. The manner of union of fungus and alga is very constant in any given species of lichen, and it is usually the fungus which determines the form of the lichen. According to external form, lichens may be classified as bushy, leafy, or crustaceous. Formerly much use was made of these distinctions for purposes of classification, but this system has now been abandoned, as separating closely related forms. Classification is now based largely on the ascospores. For anchorage and food absorption lichens are united to the substratum to very different degrees. The most intimate union is that of crustaceous, calcivorous species — Verrucaria, Staurothele, Thelidium, etc. The hyphæ of some of these species penetrate into the stony substratum in all directions, to a depth of ten to twenty millimeters or more. On the other hand, the Collemas, etc., only rest their gelatinous masses on the substratum without producing any visible change in it. Between these extremes are various intermediates. Even the hardest rocks are eroded by lichens. *Lecanora polytropa* offers a striking example of this, the hard gneiss rock to which it adheres being eroded into cavities exactly the size and shape of the lichen crusts which occupy them. In most lichens the algal elements are confined to a particular zone, but in some sorts the algæ are

uniformly distributed through the body of the thallus. This difference has little systematic value. With few exceptions, some of which are still disputed, the lichen fungi all belong to the Ascomycetes. The lichen algæ belong to the Schizophyceæ and Chlorophyceæ. Rarely filamentous forms occur. The various lichen fungi have not been found growing free except in case of a few Basidiolichenes, and some saprophyte Ascomycetes which occasionally form so-called "Half-lichens"; but in a number of cases they have been cultivated free. Many, if not all of the lichen algæ, are also believed to occur free in damp places, but owing to changes in shape and size, brought about by the presence of the fungus, there is still much uncertainty respecting the identity of the algal element in the thallus of many lichens. Quite a number of these algæ have been cultivated independently of the fungus, and ten species found in lichen thalli have been definitely identified as well-known species occurring independently of fungi. These belong to as many different genera. Almost always each species of lichen is adapted to one species of alga, but sometimes accessory species of algæ are present in the thallus, forming in connection with the lichen-fungus growths called cephalodia. The fungus provides the imprisoned alga with water and inorganic foods. It loses nothing itself by this symbiosis and gains the ability to live on bare rocks and other most resistant surfaces. What benefit the algæ derive from such unions is problematic. In the lichen thallus they are said to reach a larger size and to divide more rapidly than outside; they are also able to live and work in places otherwise unsuitable. On the other hand, they have very generally lost the ability to produce swarm spores, a function soon regained on cultivating them free from the fungus. The lichen attacks the rocks by means of acid excretions which the fungus alone appears to be unable to produce. More than sixty acids have been isolated and described, and the chemistry of the group is complex. The reproduction of the group, aside from mere vegetative propagation by soredia, which is very common, is that of the fungus. Oidial, or chlamydospore, fructification has been found only in Caliceæ. Free conidial fructification, so common in the Ascomycetes, has been found only in two lichens. Pycnidia, on the other hand, are common. The highest form of fructification is by means of ascospores. In some lichens this form is wanting, or at least has never been found. Basidiospores are said to occur in the tropical genera Cora and Corella. According to the author it is exceedingly probable that even in Collema there is no sexual reproduction. Lichens are often

brilliantly colored, browns, grays, and yellows preponderating. They are very rich in variety of forms, but these seldom resemble the separate growths of either component. Nearly 20,000 species, varieties or forms of lichens, have been described, but only about 4000 are well known. Lichenes are distributed over the whole earth. They occur farthest north and farthest south, and highest up on mountains of any plants. They are resistant to heat and to cold. Hot countries are relatively poor in species. In the Torrid zone they are found mostly on trees. The outer fungus rind is thin in the shade and thick in the sun. In hot, dry countries all the lichens have a common habit (Australia, Cape of Good Hope, Chili). Cold countries, especially in the northern hemisphere, are richest in species. Many species are widely distributed. Very few are edible. Among the latter, perhaps the most interesting is the rapidly growing manna lichen, known to the Tartars as earth bread, and a variety of which (*Lecanora esculenta* var. *jussufii*), easily blown about by the wind, and then known as "rain manna," is perhaps the manna of the Israelites.

ERWIN F. SMITH.

Agardh's Algæ.[1] — It is not often that an author, fifty years after the issue of the first part of a work, is, like Professor Agardh, still continuing its publication. Nor does this fifty years by any means cover the time during which the name of Agardh has been among the foremost in algological science. The elder Agardh, father of the present author, was already publishing his observations quite early in the present century, and in 1823 he issued the first volume of his *Species Algarum*, intending to include in the work all the species known at the time. It remained unfinished, but it marks a distinct advance in systematic algology.

Its author had the valuable faculty, in arranging a genus or group of higher rank, of seeing clearly the really distinctive characters and using them as a basis of classification. This faculty appears in even a higher degree in his son, J. G. Agardh, and for many years his *Species Algarum*, of which the first volume was published in 1848, has been the standard, especially as to the red algæ. It is only within the last three or four years that an arrangement of the red algæ, differing seriously from Agardh's, has been presented and has met with any general acceptance. The arrangement of Schmitz, as given by Engler and Prantl, is based on the details of the fertilization

[1] Agardh, J. G. *Species, Genera, et Ordines Algarum*, voluminis tertii, pars tertia. De dispositione Delesseriearum curae posteriores. Lund, 1898.

and its results, instead of on the structure of the mature cystocarp, as was Agardh's scheme. Schmitz's plan has the disadvantage that the data for its application are known in only a small proportion of the algæ; the great majority have to be assigned their place by analogy with the few of which it has been possible to study the development thoroughly; and already new observations threaten to reopen what Schmitz considered settled questions.

Agardh's system was more convenient, in that we knew the cystocarps of much the greater part of the red algæ, and might reasonably hope to find cystocarps in the few species where they were still unknown. But the chance is small of an opportunity to follow the stages from trichogyne to cystocarp in an alga from some remote part of the world, of which only a few specimens are known, and those washed up from deep water.

The present section of the work is devoted to a review of the Delesseriaceæ, of which the known species have much increased since the publication of part one of the volume in 1876. The limitations of the family are the same as before, but the subdivisions are changed, and several new genera are founded at the expense of the old genera Nitophyllum and Delesseria. The cystocarpic fruit is practically the same in all, and the characters of the tetrasporic fruit are used only for specific distinctions; all the species have the form of a flat membrane, and the distinctions are made by the greater or less number of layers of cells, the difference in size or shape of the cells of the different layers, and the presence or absence of raised mid and lateral ribs, or of veins, not elevated but formed by cells of distinctive form. Several new American species are described from Florida and from the Pacific coast.

We are sure all algologists will join in the hope that this, the latest in the author's long series of contributions, will not be the last.

F. S. COLLINS.

Greenland Algæ.[1] — It is a rather curious fact that there is hardly any part of the American coast with whose algæ we are as well acquainted as we are with those of Greenland. A number of investigators have contributed to our knowledge of this region, but much the largest share is due to the author of this work. In a former work on the same subject [2] he gave what seemed a very full account

[1] Rosenvinge, L. Kolderup. Deuxième Mémoire sur les Algues Marines de Groenland, *Meddelelser om Groenland*, XX. Copenhagen, 1898.

[2] Groenlands Havalger, *Meddelelser om Groenland*, III, 1893.

of the marine flora of the region ; but the present paper, besides contributing much to our knowledge of species already found there, adds twenty-four, of which seven are new to science. This brings the total of species to 167 ; and if we compare this number with the corresponding figures for other regions, it must be borne in mind that the author, perhaps more than any other algologist, defines species in a very broad way, often including under one specific name several forms that are elsewhere considered distinct.

Even without this allowance, however, the number must be considered very high for an arctic flora. Two causes have contributed to increase the number — the careful study of minute epiphytic and parasitic forms, and knowledge of deep-water forms obtained by extensive dredging.

Like its predecessor, the paper is illustrated by figures in the text; the latter is in French, however, instead of Danish ; a change that will be regarded as an advantage by its readers, unless they are ultra-patriotic Danes. F. S. Collins.

Botanical Notes. — The localization of the alkaloid in Cinchona has been investigated by Dr. Lotsy, whose studies of Taxodium are familiar to American botanists, and who is now connected with the laboratories which the Dutch government has established in its Indian colonies, for the investigation of the quinine-producing trees. His conclusions form No. 1 of the laboratory contributions of the *Gouvernement's Kinaonderneming*, printed at Batavia, a quarto of 128 pages, containing two folding plates and accompanied by an atlas of twenty colored plates of larger size.

Professor W. W. Bailey, of Brown University, communicates the following observations upon a South African species, in which proterandry was previously recorded by the same author in 1886.

"I have had a plant of *Veltheimia viridifolia* for some twenty years, and this year, after a long interval, it is blooming. The flowers, each of which has a long period of anthesis, are proterandrous, the stamens preceding the pistils several days in their development. They are slightly exserted, and the style, when finally it appears, is long exserted. The perianth is withering-persistent, and the raceme of some twenty or thirty flowers is over a month in blooming — perhaps two months in the development of its foot-long scape."

Boerlage's *Flora van Nederlendsch Indië*, with Part II of the second volume, recently issued, completes the Gamopetalæ, including the families Oleaceæ to Plantaginaceæ.

The *Bulletin* of the Torrey Botanical Club for March contains a revision of the United States species of Dolicholus (Rhynchosia), by Miss Vail; notes on some new and little known plants of the Alabama flora, by Dr. Mohr; new plants from Wyoming, by Professor Nelson; some new species from Washington, by K. M. Wiegand; and Part XXVI of the enumeration of the plants collected by Dr. H. H. Rusby in South America, 1885–86.

Part II of the current volume of *Minnesota Botanical Studies* contains articles on a considerable range of botanical subjects, among which are one or two of morphological and physiological value.

Professor Nelson tells in *Bulletin No. 40* of the Wyoming Experiment Station about the trees of that state. Characters of easy application are employed for their ready determination.

The newly begun *Comunicaciones* of the Museo Nacional of Buenos Aires contain articles by Spegazzini descriptive of South American phanerogams.

To students of the ecological phases of plant distribution an article by Jaccard on "La Flore du Haut Bassin de la Sallanche et du Trient," in the *Revue Générale de Botanique* for March 15, will prove of interest.

Anemone, the "wind-flower" of most persons, is said, by C. H. Toy, in *Rhodora* for March, to be really the flower of Na'mān — another name for Adonis, from whose blood the red anemone is supposed to have sprung.

Anemone riparia, a large-flowered, slender-fruited form of the northern Atlantic region, is separated from *A. virginiana* and *A. cylindrica* by M. L. Fernald in *Rhodora* for March.

Epilobium obcordatum and *Ceanothus integerrimus*, of California, are figured in the *Botanical Magazine* for February.

Viburnum lantanoides, which is commonly described as of irregular or straggling habit of growth, is shown by Dr. Ida Keller to have a decided tendency to the sympodial method of branching. — *Proc. Phila. Acad.*, 1898.

Cirrhopetalum robustum, a new Guinea orchid, is said, by MacMahon, in the *Queensland Agricultural Journal* for January, to be a good example of a carrion plant. Its flowers are pollinated by blue-bottle flies by aid of a very ingenious mechanism.

To the *Journal* of the Elisha Mitchell Scientific Society for 1898 Mr. W. W. Ashe contributes a paper on the dichotomous group of Panicum in the eastern United States. Seventy-four species — a considerable number of them new in the belief of the author — are described.

Biological notes on Indian bamboos are contributed to the January number of *The Indian Forester* by Sir Dietrich Brandis.

The toxic effects of sleepy grass, *Stipa robusta*, are being discussed by the medical and pharmaceutical press. The *Bulletin of Pharmacy* for March contains an interesting résumé of some of the recent observations.

In Nos. 8 and 9 of his "Studies in the Cyperaceæ," reprinted from recent numbers of the *American Journal of Science*, Mr. Holm treats of the genera Scleria and Lipocarpha.

Evergreens, and how they shed their leaves, is the title of *Teacher's Leaflet* No. 13, of the College of Agriculture of Cornell University.

The histological generic characters of the North American Taxaceæ and Coniferæ are well presented by Professor Penhallow in a paper reprinted from the *Transactions* of the Royal Society of Canada.

Even greenhouses, when at all extensive, have their own spontaneous flora. In the *Verhandlungen des Botanischen Vereins der Provinz Brandenburg* for 1898 P. Hennings enumerates a considerable number of fungi observed in the plant houses of the Berlin botanic garden, and finds not a few of them new to science. In *Rhodora* for May, M. Hollis Webster also publishes a similar article, dealing with fungi observed in the United States.

Collecting and preserving marine algæ, a subject of interest to every visitor to the seashore, is treated at considerable length by Professor Setchell in *Erythea* for March.

Berg und Schmidt's Atlas der Officiellen Pflanzen, of which a second edition is being issued under the care of Drs. Meyer and Schumann, has completed the third volume, which contains Pls. XCV–CXXXII.

In the *Pharmaceutical Journal*, beginning with the issue for February 25, Mr. F. Ransom is publishing a series of articles on the origin and meaning of the names of medicinal plants — these being arranged in the familiar sequence of Durand's Index.

GEOLOGY.

Rivers of North America.[1] — A book with the comprehensive title *Rivers of North America* cannot fail to arouse interest among students of nature, especially when followed by the name of the author, Professor Israel C. Russell. Curiosity is felt as to how a subject so vast as this can be concisely treated by any writer, particularly by one who has obtained many of his conceptions at first hand through observation and study in the field. Of the many ways in which the rivers of North America might be discussed there occur to the mind two as especially distinct and important. The first is a geographic description of the position, length, volume, character of water, and other existing conditions; and the second might be an analysis from the geologic standpoint of the causes of these features or of the phenomena as noted along the course of each river. This latter form of treatment is that toward which Professor Russell has directed most of his investigations, and the book reflects largely the results of his field work. In fact his book might be classed as a primer of hydro-geology or hydrology, using this latter term as distinct from hydro-geography (hydrography), or the description of bodies of water. The hydrographic or descriptive part of the subject is not neglected, being included under the head of "Characteristics of American Rivers," but is subordinate to the thorough discussion of the why and wherefore of present conditions.

Professor Russell begins by showing that the surface of the earth is a scene of continuous change, the higher portions being gradually worn away and modified by the running waters, which, gathering into streams, make for themselves valleys proportioned to the various forces at work. Beginning with rock decay and removal of the surface débris, he passes on to discuss the laws governing streams, the limitation of downward cutting to base level, the influence of the hardness of the rock in producing rapids and waterfalls, and makes note of the material carried by the streams in visible particles or in solution. Passing from the destructive or eroding action of the rivers, he takes up their constructive features and shows how the alluvial cones and deltas grade from one into the other, and brings out the origin of the stream terraces, developing the fact that these, from the industrial standpoint, are among the most important resultants in the development of the country, since they furnish some of

[1] Russell, Israel C. *The Rivers of North America.* xix + 327 pp., 17 pls., 18 figs. New York, Putnams, 1898.

our best farm lands. Following this description of down-cutting and up-building, he brings out the effect of changes in the earth's crust by elevation and subsidence and by variations in climate, particularly through glacial action, and then having touched upon the principal points of hydrology he gives, as above noted, some of the characteristics of important streams, and, in conclusion, takes up the life history of a river, showing the principal events from youth to old age.

The conception is constantly kept before the reader that a river is a living thing working out its own life history, and that the apparently permanent features which we see are the temporary products of a restless and moving organism. The converse is also enforced that for every delta, terrace, curve, rapid, or fall of the river there is a definite cause, which may be sought and explained according to general law, and that the apparent anomalies may be reconciled if the student will patiently look into the subject.

The discussion of these natural laws, while necessarily somewhat abstruse, is rendered as interesting as possible by copious illustrations taken from well-known phenomena in the geography of North America. For example, as showing the importance of the glacial epoch upon the industrial development of New England, it is stated that manufactures were established there soon after the coming of Europeans, owing to the facilities offered by the numerous small water powers. These resulted from the disturbance produced in stream development by the débris left by the retreating ice sheet of the past geologic age. South of the glacial boundary, that is, south of Pennsylvania, water power is far less abundant and mostly within the inaccessible portions of the mountains. The development of manufacturing industries hence has been delayed and attention given more largely to agriculture, for which climatic and other conditions are more favorable. Thus a decided trend was early given to the New England character and manufacturing was so firmly established that although the water powers have relatively declined in importance, and steam has usurped their place, yet the glaciated regions of the United States still continue to lead in manufacturing. Here we have a direct relation between the effects of ancient changes in geography and modern growth of civilization.

Another striking illustration of the effect of geologic changes upon industrial development is given in the case of the drowned river — the Hudson — whose valley submerged by subsidence of the earth's crust has become a long narrow arm of the sea, where the tides rise and fall. During its early history the river cut its deep channel

across a mountain range as it was slowly being elevated, and continued its course far out into what is now the present ocean, to a point at least eighty miles eastward of Long Island. In late geologic time a downward movement of the earth's crust, too insignificant to be noticed in comparison with the whole diameter of the earth, has brought the former mouth of the river below sea level, and the salt water gradually encroaching has filled the broad valley where now is the important harbor of New York, and has made possible ocean navigation far inland. The influence of this easy route of communication up to the site of the present city of Albany, and from that point by easy paths up the broad Mohawk to the Great Lakes, determined the history, not only of New York State, but of the people of the continent, and has resulted in making this state the richest of the American Union.

F. H. NEWELL.

PETROGRAPHY.

The Volcanics of San Clemente. — San Clemente Island, off the coast of Southern California, is built up[1] almost exclusively of lava flows, volcanic breccias, and ash deposits. The principal eruptive is a pyroxene-andesite. In addition to this, there are smaller areas of rhyolite and dacite. The andesite consists of a mediumly basic plagioclase, augite, often hypersthene and magnetite as phenocrysts in a ground mass composed of the same minerals, with a larger or smaller proportion of glass. The dacite lies above the andesite, and the rhyolite above the dacite. The former rock contains the same phenocrysts as the andesite, but in the ground mass there is considerable quartz intergrown with oligoclase in micropoicilitic patches, and a large quantity of orthoclase, likewise in micropoicilitic intergrowths with the same plagioclase. The quartz and orthoclase appear to form the matrices in which laths of the plagioclase are imbedded.

The rhyolite is of an unusual type. It comprises phenocrysts of andesine, a few of hypersthene and magnetite, and an occasional one of augite in a microgranular and glassy matrix. The crystalline portion of the matrix is composed of quartz, orthoclase, and andesine, forming bands and lenses separated from one another by bands of glass.

[1] Smith, W. S. T. *Eighteenth Ann. Rep. U. S. Geol. Survey, 1898*, Pt. ii, p. 459.

The approximate composition of the rhyolite (I) and of the andesite (II) is as follows:

	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	Na_2O	K_2O	Ign.	Tot.
I.	70.39	14.09	.53	2.12	3.08	.62	3.70	3.51	2.50 =	100.54
II.	66.85	14.08		3.06	4.69	.91	3.80	2.57	2.07 =	98.03

Contact Phenomena in Michigan. — Between the graywackes, slates, etc., of the Mansfield formation, in the Crystal Falls district of Upper Michigan, and a mass of diabases on their flank, is a contact zone of dense hornstone-like rocks that have been studied by Clements.[1] As the intrusives are approached the graywackes and slates are changed into spilosites, desmosites, and finally adinoles.

The unchanged clay-slates are banded rocks composed of quartz, muscovite, rutile, hematite, and an occasional needle of actinolite in a mass of feldspathic dust. With these are phyllites, which differ from the slates in being richer in muscovite, and in containing no feldspathic interstitial substance. The contact rocks consist of quartz, albite, biotite, chlorite, muscovite, actinolite, rutile, epidote, and iron oxides. The spilosites are mottled, the spots usually being richer in chlorite than the surrounding matrix. In the few instances in which the spots are lighter colored, they are composed predominantly of feldspar. The desmosites are like the spilosites, except that the spots are united into bands. In the adinoles actinolite is the chief colored constituent, while in the spilosites and desmosites chlorite plays this rôle. The chemical relationships existing between the unchanged and the altered rocks are shown by the following analyses (in addition to the constituents indicated below there are also indicated in the original small quantities of others):

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	H_2O	P_2O_5	C
I.	60.28	.69	22.61	2.53	.45	.13	1.35	5.73	.54	4.22	0.3	.97
II.	52.51	1.70	19.00	3.31	7.19	1.55	3.29	.70	6.72	3.60	.15	
III.	57.77	.92	19.35	1.29	3.37	1.71	4.35	.22	8.22	2.52	.04	
IV.	74.16	.37	11.85	.82	1.66	2.10	2.10	.15	6.57	.57	.09	

I = slate, II = spilosite, III = spilosite, IV = adinole.

Silica increases as the igneous rock is approached, and alumina and the iron oxides decrease. Moreover, the potassa, which is the predominant alkali in the unaltered slate, is replaced almost completely by soda in the altered forms. The clay-slate is clearly clastic; the altered rocks are entirely crystallized. The former contains no albite, while the latter are rich in it. It appears that, in

[1] *Amer. Journ. Sci.*, 1899, p. 81.

the change from the slate to the adinole, an actual addition of material from the igneous rock has taken place.

The Granitic Rocks of the Sierra Nevadas.—Turner[1] describes the granular complex of the central and southern Sierra Nevadas as comprising nearly the entire range of plutonic rocks. They are associated more or less closely with gneisses, some of which may be sedimentary while others are igneous. Among the rocks belonging in the granite family the author distinguishes seven types, a biotite granite, a granodiorite, a quartz monzonite, both in porphyritic and in non-porphyritic phases, soda-granite, aplite, potash-aplite, pegmatite, and a type designated as the bridal veil granite.

The granodiorites constitute a portion of a huge batholite, the parts of which have been differentiated into quartz-diorites, quartz-mica-diorites, quartz-hornblende-diorites, and quartz-pyroxene-diorites, gabbros, and olivine-gabbros. Typical granodiorite is an aggregate of plagioclase (usually andesine), quartz, orthoclase, and either biotite or amphibole, or both. The quartz-monzonites contain oligoclase instead of andesine. They are more acid than the granodiorites, as shown by the analysis below. The bridal veil granite is a fine-grained white rock that often possesses an orbicular structure — the nodules consisting of a white nucleus of quartz and feldspar surrounded by a zone rich in biotite.

The aplites and soda-granites are also white rocks in which albite is the principal feldspathic component. Quartz-diorite aplites occur in dykes cutting quartz-diorite. These are regarded as genetically connected with the more basic diorite with which they are associated, just as the potash aplites are related to the granodiorites and quartz-monzonites in which these rocks occur. The feldspar of the quartz-diorite aplite is chiefly andesine.

Analyses of the most important types of rocks discussed are shown in the following figures:

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	H_2O	P_2O_5	Tot.
I.	70.75	.29	15.51	.85	1.34	2.82	.55	4.28	3.11	.46	.10	= 100.34
II.	65.48	.52	16.05	1.47	3.06	4.88	2.13	2.43	3.49	1.27	.12	=
III.	66.83	.54	15.24	2.73	1.66	3.59	1.63	4.46	3.10	.56	.18	= 100.82
IV.	74.21	.30	14.47	.35	.50	1.71	.28	.10	7.62	.38	.07	= 99.99
V.	69.66	.21	17.57	.21	1.04	4.54	.58	.71	4.91	.55	.03	= 100.09
VI.	76.00	.08	13.23	.54	.35	1.38	.09	5.40	2.74	.43	.02	= 100.37

I = average of three biotite-granites, II = average of five granodiorites, III = quartz-monzonite, IV = soda-aplite, V = quartz-diorite aplite, VI = average of two potash-aplites.

[1] *Journ. of Geology*, vol. vii, p. 141.

The totals include small amounts of MnO, SrO, BaO, and other oxides.

The Rocks of Mount Rainier. — The volcanics of Mount Rainier[1] are basaltic and andesitic lavas and tuffs, passing into one another by almost imperceptible gradations. The predominant andesite is hypersthenic, but other pyroxenes often occur with the hypersthene and sometimes replace it entirely in the rock mass. The platform upon which the volcanics were extruded consists of a granite either hornblendic or biotitic.

Luquer's Minerals in Rock Sections[2] is an attempt to furnish to students in as few words as possible an account of the practical methods of identifying the minerals occurring in rocks by means of their optical and other physical properties as they may be observed in thin sections under the microscope.

The general principles of optics are discussed in the first thirty-four pages of the book as an introduction to the description of the characteristics of the individual minerals. Unfortunately, this discussion is so condensed that it can afford no help to the student unless it is accompanied by explanatory lectures. As a summary of a course of lectures in optics it might possibly be of value. The discussion explains nothing; it is merely a dogmatic statement of facts, sometimes so bare of explanatory or illustrative phrases as to leave only a confused impression in the mind of the reader. This is particularly noticeable in the case of the definitions. For instance, the first time the term "extinction angle" is used, it is described as the angle between the axis of elasticity and the crystallographic axis, without reference in any way to the fact of extinction. There is much loose expression in this part of the book, which, of course, might easily be corrected in a new edition.

The chapter on the microscopic features of the individual minerals covers forty-five pages. Here we find a very concise description of the principal diagnostic characters of the minerals most frequently found in rocks, with brief remarks on their occurrence.

A noteworthy feature of the volume is the clear manner in which directions are given for the manipulation of the apparatus employed

[1] Smith, G. O. *Eighteenth Ann. Rep. U. S. Geol. Survey*, Pt. ii, p. 416.

[2] *Minerals in Rock Sections.* The practical methods of identifying minerals in rock sections with the microscope. By L. McI. Luquer, C.E., Ph.D. vii + 117 pp., 48 figs. Price $1.40. New York, D. Van Nostrand Co., 1898.

in the investigation of the optical constants. The methods described, while simple, are those in most use among practical petrographers. Some of them are here given for the first time in English text.

Though the book has some faults, some of them serious ones in a student's text-book, it will unquestionably be of service as affording a convenient summary of lecture courses. It is also a good note-book on the microscopical characters of minerals.

The Fuess Catalogue.[1] — The author, who for several years has directed the optical section of the Fuess establishment, has here given a complete description of all the Fuess instruments made for optical or allied purposes, including, therefore, spectro- and refractometers and spectro-photographic apparatus, goniometers, polaniscopes and microscopes, section-cutting machinery, heliostats, and projection and micro-photographic apparatus. The work is really a text-book for the principles of construction, use, and adjustment of these instruments, and contains numerous additional references to the literature of the subject. The abundant illustrations elucidate the text.

Petrographical Notes. — Patton[2] notes that mica-schists in contact with pegmatite veins on the Belcher Hill road between Golden and Central City, Colorado, are impregnated with tourmaline to a very great extent. Sometimes the tourmaline is noticed in the cleavages of the schist, when the resulting rock is a banded or laminated one. Where the contact action was more severe the tourmaline is in streaks, which, however, bear no definite relation to the original cleavage direction of the schist, which in many cases has been obliterated. The tourmalinized schists are composed of quartz and muscovite, in addition to the tourmaline, while the schists that have not been impregnated with tourmaline contain an abundance of biotite. The tourmaline, as seen in thin section, is discovered to be full of quartz inclusions, and to enclose here and there small grains of rutile or zircon. The pegmatite veins that are supposed to have caused the alteration in the schists are thought by the author to be segregation veins.

Kemp[3] is continuing his studies on the geology of Essex County, N. Y. In a recent report he describes briefly the rocks of the town-

[1] Leiss, C. *Die optischen Instrumente der Firma R. Fuess, deren Beschreibung, Justierung, und Anwendung.* 233 figs., 3 plates. Leipzig, W. Engelmann, 1899.

[2] *Bull. Geol. Soc. Amer.*, vol. x, p. 21.

[3] *Fifteenth Ann. Rep. State Geologist* (New York), p. 575.

ships of Chesterfield, Jay, Wilmington, St. Armand, North Hudson, Schroon, Ticonderoga, Minerva, and Newcomb. Gneisses, gabbros, and anorthosites are the most interesting of the rocks mentioned. The latter exhibit beautifully the effects of dynamo-metamorphism.

In the Lake Placid district in Essex County, in addition to the rocks above mentioned, Kemp[1] finds limestones, quartzites, and granites. The geology of the district is described popularly in a small pamphlet, which is accompanied by an excellent map.

[1] *Bull. New York State Museum*, vol. v, No. 20, p. 52.

NEWS.

The New England Botanical Club has just issued its neatly printed club-book for 1899, containing the constitution of the club, list of the officers, members, and personnel of its various committees. There are now forty-four resident members (those living within twenty-five miles of Boston), and forty-two non-resident. It is evident from the list that the club already includes nearly all the publishing botanists who are engaged in the investigation of the New England flora.

After the close of Vol. II the *Zoölogical Bulletin* will be continued under the name of *The Biological Bulletin*, and will be published under the auspices of the Marine Biological Laboratory at Woods Holl, Mass. The journal will be enlarged to include general biology, physiology, and botany; and it will contain occasional reviews and reports of work and lectures at the Marine Biological Laboratory.

Brighton, England, is to have a new zoölogical garden.

Mr. Georges Clautrian, of Brussels, receives a prize of 600 francs from the Belgian Academy, for his researches in the chemistry of digestion in carnivorous plants.

We note the statement in a recent number of *Natural Science* that the gypsy moth is rapidly disappearing from England, and in certain localities it is no longer to be found. Possibly they have emigrated, attracted by the generosity of the Massachusetts Legislature.

The Egyptian government is to begin a scientific study of the fishes of the Nile, the work being done by English naturalists.

Falcon Island, near the Tonga group, has disappeared after an existence of thirteen years. It was found as a volcanic upheaval. In this connection we note a submarine eruption in March, causing a "tidal wave" which did great damage in the Solomon Islands.

A sketch of the life of the late James Hall, with a presumably complete bibliography of his scientific writings, appears in the March number of the *American Geologist*.

Mr. J. Stanley Gardiner has been appointed Balfour student of the University of Cambridge. The studentship is for three years and has an annual value of £200. It is designed for research in the line of animal morphology.

Mr. W. W. Skeat, accompanied by Messrs. Evans and Aumandale as zoölogists, and Mr. Gwynne-Vaughan as botanist, goes to the Malay peninsula to make investigations upon its natural history. The expedition is aided by the University of Cambridge.

The Belgian Royal Academy has awarded a prize of 600 francs to Professor L. Cuénot, of Nancy, France, for his studies of the nephridial system of the molluscs.

The *Concilium Bibliographicum* announces their new address to be 38 Eidmattstrasse, Zürich-Neumünster. The new house contains a press room in the basement, offices, storerooms, and composing rooms in two upper stories. Dr. J. Dewitz has been appointed resident assistant and Dr. L. Lalry correspondent.

The board of estimate and apportionment for the City of New York has set aside $63,000 for the zoölogical garden in Bronx Park. It is also proposed to raise the appropriation for the American Museum of Natural History from $90,000 to $130,000 a year.

Dr. Adolph Fick, professor of physiology in the University of Würzburg, has resigned at the age of seventy years.

Several graduate fellowships and scholarships in scientific departments are vacant this spring at the University of Nebraska. Holders of these positions are expected to give a certain portion of their time to assistance in the department in which they are working.

Appointments: Vidal de la Blache, professor of geography in the University of Paris. — Mr. Joseph Barrell, instructor in geology and lithology in Lehigh University, South Bethlehem, Penn. — G. Gilbert Cullis, assistant professor of geology in the Royal College of Science, South Kensington, London. — Ulric Dahlgren, assistant professor of histology in Princeton University. — Dr. William Morris Davis, Sturgis-Hooper professor of geology in Harvard University. — A. W. Hill, demonstrator in botany in the University of Cambridge. — Dr. Moritz Hoernes, professor extraordinarius of prehistoric archæology in the University of Vienna. — Dr. Robert Tracy Jackson, assistant professor of paleontology in Harvard University. — Dr. Bengst Jöhns-

son, professor of botany at the Akademie at Lund, Sweden. — Dr. Adalar Richter, professor extraordinarius of botany in the University of Klausenburg. — Mr. W. E. D. Scott, curator of the ornithological collections of the Green School of Science in Princeton University. — Dr. Streckeison, privat docent for geography in the University of Basel. — Dr. Tobler, privat docent for mineralogy in the University of Basel. — Dr. W. F. R. Weldon, of London, Lenacre professor of comparative anatomy in the University of Oxford, as successor to Professor E. Ray Lankester. — Dr. R. von Wettstein, professor of botany and director of the botanical gardens of the University of Vienna. — Jay Backus Woodworth, instructor in geology in Harvard University.

Deaths: Dr. Dareste de la Chavanne, the French anthropologist and teratologist. — Rev. William Colenso, a collector and student of New Zealand anthropology, February 10, aged 88. — John Collett, for several years state geologist of Indiana, at Indianapolis, March 15, aged 71. — Mr. Thomas Cook, teacher of anatomy, in London, February 8. — Alexandre Laboulbene, entomologist and pathologist, author of a *Faune Entomologique de France*, aged 73. — Dr. Franz Lang, teacher of natural history in the cantonal school of Solothurn, Switzerland, aged 78. — Dr. William Rutherford, professor of physiology in the University of Edinburgh, February 21, aged 60. — Dr. Carl Schönlein, assistant in the Zoölogical Station at Naples, aged 40. — Sir John Struthers, emeritus professor of anatomy in the University of Aberdeen, February 24, aged 75. — Gianpaolo Vlacovich, professor of anatomy at Padua, Italy.

Othniel Charles Marsh, professor of paleontology in Yale University, died March 18, 1898. He was born at Lockport, N. Y., Oct. 29, 1831, and was graduated from Yale College in the class of 1860. For two years after graduation he pursued studies in mineralogy in Yale, and then went abroad for three years of study in German universities. In 1866 he returned to Yale as professor of paleontology, a position he held until his death. Professor Marsh was never married and was without near relatives. His entire fortune was left by will to Yale University, aside from a bequest to the National Academy of Science of $10,000.

CORRESPONDENCE.

On the Use of the Terms "Heredity" and "Variability."

To the Editor of the American Naturalist:

Sir, — The necessity of an accurate terminology in the discussion of such an abstruse and complicated subject as the evolution philosophy has always been recognized. Every one is satisfied to have each writer coin as many new words, or to re-define as many old ones, as the discussion of his subject demands. And so we have numerous technical terms, as "germ-plasm," "idioplasm," "gemmule," "stirp," "id," "biophore," "diplogenesis," etc. It is, therefore, the more surprising to find so many really serious fallacies and disagreements creeping into evolutionary discussion through the equivocal use of such common terms as "heredity" and "variability."

These two words have been often, perhaps usually, regarded as antonyms. Heredity and variability have been treated as two diametrically opposing laws. Even when the opposition was not so much emphasized, they have been treated as two separate and sharply distinguished principles. Darwin treats them so. Weismann follows a similar usage, and, in general, the uncritical custom follows the same line. But this investment of the terms "heredity" and "variability" with two sharply contrasted meanings is essentially illogical. This is not a new discovery by any means, for it will be found on examination, I think, that the leading writers on evolution topics have shrunk, consciously or unconsciously, from bringing these terms into conflict at any critical point.

The beginning of the difficulty has been in the assumption that organic life began under the absolute dominion of the law of heredity. Later, according to this assumption, variability crept in, and the course of organic reproduction departed farther and farther from the rigid line of heredity. Bailey has controverted this assumption in his *Survival of the Unlike* by another equally gratuitous assumption. The law of heredity is said to be that like begets like; but Bailey asserts that, in the original and normal course of organic reproduction, "unlike begets unlike." Of course neither statement is absolutely true; but if both are properly qualified they acquire practically identical mean-

ings. What we actually know without contradiction is that like never begets absolute likeness, nor yet absolute unlikeness. It is, then, doing a violence to all our observation of nature to make the law "like begets like" mean absolute duplication of parent in offspring. It is not good English to make likeness mean identity, unless it be by special definition. Things are like which are similar. And if the old statement that "like begets like" is read to mean "similar begets similar," we have a statement of the obvious truth. And, moreover, there is no reason to suppose that the course of reproduction was ever different.

In this view of the case heredity and variability belong in the same scale. I have been in the habit of illustrating this relation by reference to heat and cold in the thermal scale. More cold means simply less heat. More variability means simply less rigid heredity. As the power of heredity wanes, variability waxes. And so, just as the physicist, for the sake of an accurate terminology, speaks only of heat, the biologist ought to have one general name for the one great law of reproduction. The term "heredity" would answer all purposes, had its proper meaning not already been clouded by the attachment of unwarranted definitions to it, and were its etymology not also a trifle awkward for the uses required. In fact we all speak of variability hundreds of times when we would speak of heredity, were it not for the convenient adjective "variable" with its easy comparisons. Partly to get away from false ideas of heredity, and partly to keep clear the unity of the reproductive law, I have adopted another word for use in my classes, and now speak of "the allophysical law." If the allophysical law were to be stated, it would be in the words "similar begets similar" ("like begets similar" would be more logical, no doubt; but it is easier to stick to the old order), or in the words "like begets like," properly explained.

If some one will give us a simple word to take the place of heredity and variability in their combined meaning, and one which shall be accompanied by some manageable and easily compared adjective, it will be a great convenience to future discussion.

FRANK A. WAUGH.

UNIVERSITY OF VERMONT.

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(The regular exchanges of the *American Naturalist* are not included.)

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DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE

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All naturalists who have anything interesting to say are invited to send in their contributions, but the editors will endeavor to select for publication only that which is of truly scientific value and at the same time written so as to be intelligible, instructive, and interesting to the general scientific reader.

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OBSERVATIONS ON OWLS, WITH PARTICULAR REGARD TO THEIR FEEDING HABITS.

THOMAS H. MONTGOMERY, Jr.

The following notes, from observations on the short-eared owl, *Asio acciptrinus* Pall., and the long-eared owl, *A. wilsonianus* Less., present some results from the examination of a considerable number of food pellets of these birds. These data may prove of interest from three points of view: (1) the kind of food eaten by these owls; (2) the relation of the amount of food found in the pellets beneath a roosting place to the total amount of food consumed; and (3) the comparative numerical abundance of small mammals in the vicinity, as deduced from their remains in the pellets.

At Christmas, 1898, four long-eared owls were found roosting in an arbor vitæ tree on my father's place, "Ardrossan," near West Chester, Penn. Before coming to this tree they had roosted in a small outleaved beech, until driven away by gunners. These owls were under my daily observation from Dec. 25, 1898, to Feb. 22, 1899. The tree on which they roosted is a large one, nearly forty feet in height, without especially dense foliage, situated between a house and a stable, about a dozen feet from either. Close to it passed many times a day people

and carriages, without having the effect of frightening the birds; and they showed no concern when I collected the food pellets from the ground beneath them. In the coldest part of the winter the owls regularly faced the east, and at one time, when four roosted together, three of them roosted near the center of the tree, one near the top, and each occupied regularly a particular branch.

About thirty feet to the southeast of the house is a magnificent Norway spruce, the roosting place of a short-eared owl. I first observed this bird on February 2, and kept it under regular observation from February 26 to March 26, except for a lapse of a few days between March 8 and 14. For a part of this time one of the long-eared owls, after leaving the arbor vitæ tree, roosted in this Norway spruce also.

These two trees were the only regular roosting places of owls in the neighborhood at this time, though there were a number of evergreen trees in the vicinity which were casual feeding perches, under which I found pellets.

My observations were of the following nature: Each day the number of owls were counted on the two roosts, and at regular intervals (usually each Sunday) all pellets were collected from the ground beneath each roost. These pellets were carefully examined, the number and kind of animal remains in them noted, and so the daily food average per owl computed. Here I wish to thank my friend Mr. Witmer Stone, curator at the Philadelphia Academy of Natural Sciences, for his assistance in determining the species of mammals.

First, a few notes as to the construction of the food pellets. It is well known that owls, as a rule, swallow their prey whole, that the food remains in the stomach until all digestible substances are extracted and passed into the small intestine, and that finally the remaining mass of undigested substances (bones with hair or feathers, hard parts of insects, etc.) is disgorged as a pellet (bolus). The pellets are more or less ovoid in form, and when freshly disgorged covered with a slimy mucus. Each pellet, of the two species of owls studied, usually contains the remains of only one food individual (*i.e.*, one mouse or one bird); about one in twenty contains two individuals; rarely

are more than two present in the same pellet, and pellets of this nature are considerably longer than usual, though of the ordinary diameter. The pellet, when the object eaten is a mammal or bird, is composed of a tightly welded mass of bones and hairs, or feathers. In the stomach of the owl the food mass must be subjected to a vigorous churning process, for only such a process could serve to explain the close welding of the materials in the ejected pellet. In a pellet there are no empty spaces, but the hairs or feathers fill tightly all the spaces between the bones, and are jammed into all grooves and foramina of the latter, the pellet, when fresh, being so compact that it cannot be roughly torn apart without breaking the bones contained in it. The skulls of mice are usually found crushed in the occipital region (the weakest portion), usually more or less intact anterior to the frontal; out of 570 skulls of the meadow mouse taken by me from pellets, only some fifty had the occipital region uninjured and attached to the rest of the skull; when several mice are contained in the same pellet, the state of preservation of the skulls is better than usual. It is truly remarkable how the hair is worked, by the churning process of the owl's stomach, into all cavities of the skull. There is always a tight wedge of hair in the preorbital foramen, in the foramen lacerum, in the ear and nasal cavities, as well as in smaller apertures. When the occipital region of the skull is crushed, the cranial cavity contains a tight wad of hair; and in a few skulls which remained intact the whole cranial cavity was densely packed with hair which had been forced through the foramen magnum! The lower jaws are usually well preserved (though their angular and coronary processes are frequently broken), and teeth are well preserved. Of the other bones of the mouse's skeleton contained in a pellet, it is strange that the slender and delicate ulnæ and radii are usually intact; the proximal end of the humerus is usually dislocated; the femora, tibiæ, ilia, vertebræ, and small bones of the hand and foot are usually uninjured, while the ribs, scapulæ, and fibulæ are usually broken. The less strongly built skulls of shrews and birds are considerably more crushed. As MacGillivray noted in 1836, the linings of birds' gizzards are disgorged intact

in the pellets. As far as I can determine, the gastric juices of the owls have no noticeable action upon bones.[1]

I.

The following tables represent the food eaten by the owls under my observation. Table I is for the long-eared owls on the arbor vitæ tree; Table II for the long-eared and the short-eared owl on the Norway spruce. For each table the first

TABLE I. ARBOR VITÆ TREE.

Date of Collection	Number of Owls on the Tree		Contents of Pellets	Daily Food Average
	Dec. 25,	4		
	" 26,	4		
	" 27,	4		
	" 28,	4		
	" 29,	4		
	" 30,	4	1 Finch	
	" 31,	4	1 Blarina	
Jan. 8	Jan. 1,	4	1 *Micr. pinet.*	
	" 2,	4	139 *Micr. penn.*	
	" 3,	4	14 *Micr. undet.*	
	" 4,	4		
	" 5,	4		
	" 6,	4		
	" 7,	4		
	" 8,	4		
	Jan. 9,	4		
	" 10,	4		
	" 11,	4	1 Peromyscus	
Jan. 15	" 12,	4	1 *Micr. pinet.*	1.6
	" 13,	4	43 *Micr. penn.*	
	" 14,	4		
	" 15,	4		

[1] The pellets of hawks (I am familiar with those only of *Falco sparverius*) are very different from those of owls. The pellets of the sparrow hawk are smaller, elongate, usually pointed at the ends, and more or less spirally twisted. In them there is frequently no trace of bones, and when the latter are present they are usually in a fragmentary condition. A hawk tears its prey to pieces in the process of eating, which would account for the breaking of the bones.

TABLE I. — *Continued.*

Date of Collection	Number of Owls on the Tree			Contents of Pellets	Daily Food Average
Jan. 22	Jan.	16,	4	2 *Micr. pinet.* 41 *Micr. penn.* 4 *Micr. undet.*	1.57
	"	17,	4		
	"	18,	4		
	"	19,	4		
	"	20,	5		
	"	21,	4		
	"	22,	5		
Jan. 29	Jan.	23,	5	1 Mus. 47 *Micr. penn.*	1.92
	"	24,	0		
	"	25,	4		
	"	26,	4		
	"	27,	4		
	"	28,	4		
	"	29,	4		
Feb. 5	Jan.	30,	4	1 *Passer domesticus* 1 *Micr. pinet.* 25 *Micr. penn.*	2.16
	"	31,	0		
	Feb.	1,	1		
	"	2,	0		
	"	3,	3		
	"	4,	2		
	"	5,	2		
Feb. 26	Feb.	6,	2	1 Peromyscus 1 *Micr. pinet.* 24 *Micr. penn.*	1.86
	"	7,	1		
	"	8,	2		
	"	9,	2		
	"	10,	1		
	"	11,	2		
	"	12,	2		
	"	13,	1		
	"	14,	0		
	"	15,	0		
	"	16,	0		
	"	17,	0		
	"	18,	0		
	"	19,	0		
	"	20,	0		
	"	21,	0		
	"	22,	1		

Table II. Norway Spruce Tree.

Date of Collection	Number of Owls on the Tree	Contents of Pellets	Daily Food Average
Feb. 26	Feb. 2, 5 *wils.*, 1 *acc.* " 3, 1 *acc.* " 19, 1 *wils.* " 24, 1 *wils.* " 26, 1 *wils.*	50 *Micr. penn.*	
Mar. 5	Feb. 27, 1 *wils.* " 28, 1 *wils.* Mar. 1, 1 *wils.* " 2, 1 *wils.* " 3, 1 *acc.* " 4, ? " 5, 1 *acc.*, 1 *wils.*	1 *Blar. parva* 1 Zapus 1 Cambarus 1 Finch (?) 27 *Micr. penn.*	2.42 ?
Mar. 14	Mar. 6, 1 *acc.*, 1 *wils.* " 7, 1 *acc.* " 8, 0 ? " 14, 1 *acc.*	1 *Passer domesticus* 1 *Melospiza fasciata* 1 *Blar. parva* 18 *Micr. penn.*	
Mar. 19	Mar. 15, 1 *acc.* " 16, 1 *acc.* " 17, 1 *acc.* " 18, 1 *acc.* " 19, 1 *acc.*	1 *Melospiza fasciata* 6 *Micr. penn.*	1.2
Mar. 26	Mar. 20, ? " 21, 1 *acc.* " 22, 1 *acc.* " 23, 1 *acc.* " 24, 1 *acc.* " 25, 1 *acc.* " 26, 1 *acc.*	1 Bird 4 *Micr. penn.*	.57

vertical column gives the date of collection of pellets; the second, the number of owls on the tree each day; the third, the contents of the pellets; the fourth, the number of small mammals (mice and shrews) eaten by each owl daily. This number was ascertained at each period of collection of pellets, by dividing the total number of mammals by the number of days when owls were present on the tree, and dividing the

resultant number by the total number of owls divided by the number of days. The second vertical column of Table II shows which of the two species of owls were present each day, by the abbreviations "acc." and "wils." for *Asio acciptrinus* and *A. wilsonianus* respectively. In the third vertical column of both tables "Micr. penn." stands for *Microtus pennsylvanicus* (meadow mouse); "Micr. pinet.," for *M. pinetorum* (pine mouse); "Micr. undet.," for species of Microtus which could not be determined owing to the poor state of preservation of the remains; "Mus," for *Mus musculus* (house mouse); "Peromyscus," for *P. leucopus* (white-footed mouse); "Zapus," for *Z. hudsonius* (jumping mouse); "Blar. brev.," for *Blarina brevicauda;* and "Blar. parva," for *B. parva.*

For each owl on the arbor vitæ tree the daily average of small mammals, in the different weeks, varied from 1.57 to 2.16. The collection of pellets made on January 8 had been accumulating for an undetermined period antecedent to that date. It is interesting to note that in the especially cold and stormy month of February the amount of food obtained by the owls was up to the average. The contents of these pellets may be summarized: 2 birds, 1 Blarina, 2 *Peromyscus leucopus*, 1 *Mus musculus*, 6 *Microtus pinetorum*, 319 *M. pennsylvanicus*, and 18 undetermined individuals of Microtus.

For the owls on the Norway spruce the daily average of small mammals per owl was 1.2 one week, and only .57 another; for the week given in the second transverse column of this table it would be 2.42, provided two owls were present each day, which I have good reasons to suppose to be the case, though I did not see the two each day. I could not determine how long the pellets had been accumulating which are given in the first transverse column. To summarize the pellets of this table: 1 Cambarus, 5 birds, 2 *Blarina parva*, 1 *Zapus hudsonius*, and 105 *Microtus pennsylvanicus*. On the Norway spruce the short-eared owl was the regular resident, the long-eared owl more irregular in occurrence; and it is probably due to the differences in the feeding habits of the former that the bones in the pellets were more badly broken than is the case with long-eared owls, and that the daily food average was smaller.

Within a radius of an eighth of a mile of these two trees there are a number of evergreen trees, under which I found at various times considerable numbers of pellets; since these proved to be not roosting but merely casual feeding perches, and since I found no other owls roosting in the vicinity, it would seem very probable that these pellets, or most of them, were produced by the owls observed by me. These pellets contained the remains of 5 small birds (including Regulus, Junco, Certhia), 3 *Blarina brevicauda*, 3 *B. parva*, 1 Blarina, undetermined, 2 *Zapus hudsonius*, 3 *Peromyscus leucopus*, 1 *Microtus pinetorum*, 139 *Microtus pennsylvanicus*, and 4 undetermined individuals of Microtus. Pellets found under trees which are not day roosts would necessarily contain the remains of animals eaten by the owls in the early evening, before they returned to their roost.

II.

The very fact that pellets are found beneath trees which are merely feeding perches, as they have been termed by me, proves that the pellets beneath a roost do not represent all produced by owls. How great a proportion of all the food consumed is contained in the roost pellets cannot be determined by field observation alone, since it is impracticable to follow and observe owls during their nocturnal wanderings. To determine how much food is eaten by owls, and how many pellets are disgorged away from their roosting places, I have compared my data with those given by Dr. A. K. Fisher in his very able and thorough work, "The Hawks and Owls of the United States in their Relation to Agriculture" (*U. S. Dept. Agric. Bulletin*, No. 3, 1893). Dr. Fisher tabulates the results of the examination of several thousand stomachs of our rapacious birds. To be sure, the number of objects found in an owl's stomach do not necessarily represent all eaten by that owl in the course of a day. But since Fisher's tables show per bird a somewhat higher average of food contents than do mine on pellets, his figures would approximate closer to the total food consumption per owl, and on this account the comparison of the two sets of data may be of interest.

Fisher gives the results of examination of the contents of 92 stomachs of *Asio wilsonianus*, and of 87 stomachs of *A. acciptrinus* (when we eliminate those stomachs which were found empty, and which probably were of birds shot in the daytime). I have carefully computed from Fisher's tables for these two species of owls the exact number of food objects in detail per stomach, and the results may thus be compared with my data, counting in only mice, shrews, and small birds.

A. wilsonianus	(Fisher)	mice, shrews,	1.52 ; birds, .26.
	(mihi)	" "	1.57, 2.16 ; birds, .08.
A. acciptrinus	(Fisher)	" "	1.78 ; birds, .22.
	(mihi)	" "	.57, 1.2 ; birds, .14, .2.

This comparison of the two sets of data would show that the long-eared owl probably does the greater part of its digestion, and disgorges most of its pellets on its roost. But the short-eared owl, since here there is a marked discrepancy between the figures of Fisher and myself, would appear to disgorge a smaller proportion of its pellets at its roost, and a considerable number at casual feeding perches; this is probably referable to the more crepuscular mode of life of the short-eared owl, which leaves its roost earlier in the evening, and returns to its roost later in the morning. The food of the short-eared owl is more diversified than that of the other species, probably due to its covering more varied feeding grounds in its hunts.

III.

Finally, as to the numerical abundance of our mice and shrews, as deduced from the relative abundance of their remains in owl pellets. It must be kept in mind that owls hunt for their food mainly on open meadow and marsh land, less in thick woodland. Their hunting is also mainly done by night. Accordingly, woodland and diurnal mammals would be less frequently destroyed by them than would nocturnal mammals of the more open districts. But the following figures would give a fair comparison of the numerical abundance of such small nocturnal mammals as are found at night in the hunting areas

of the long-eared and short-eared owls. To the data of contents of pellets from the Norway spruce, and arbor vitæ trees, and of feeding perches within a radius of an eighth of a mile of them, I will add the contents of pellets found at other localities in the course of this season of observation, and we find the following numbers of individuals of different species of mice and shrews: *Microtus pennsylvanicus*, 570; *M. pinetorum*, 7; *Microtus* (undetermined, but probably *pennsylvanicus*), 26; *Zapus hudsonius*, 3; *Peromyscus leucopus*, 5; *Mus musculus*, 1; *Blarina parva*, 10; *B. brevicauda*, 6, and *Scalops* (?), 1. Thus *Microtus pennsylvanicus* would appear to be the most abundant mouse, and *Blarina parva* the commonest shrew.

In conclusion, it may be noted that these data add further support to the well-proven results of ornithologists, that our local owls (with the possible exception of the great-horned owl) are of the greatest benefit to the agriculturist. Our three commonest local owls, the screech, long-eared, and short-eared (as well as the rarer acadian and barn owl), are indefatigable destroyers of mice and insects. But since this is the case, and since the group of the owls is one of great interest to the naturalist, it is to be hoped that future students of their dietary habits will avoid studying their stomachs for this purpose, and in order not to destroy them examine their food pellets instead.

THE WINGS OF INSECTS.

J. H. COMSTOCK AND J. G. NEEDHAM.

Chapter IV (*Concluded*).

The Specialization of Wings by Addition.

V. The Tracheation of the Wings of Orthoptera.

The study of the tracheation of wings of orthopterous nymphs was undertaken merely for the purpose of determining the homologies of the wing-veins in this order; but some of the results attained have a much wider bearing, giving a hint as to the position of this order in the class Insecta. For this reason, after setting forth the conclusions regarding the homologies of the tracheæ of the wings, a brief discussion of the taxonomic bearing of some of these conclusions will be given.

The Homologies of the Principal Tracheæ of the Wings of Orthoptera. — In this investigation representatives of the Blattidæ, Acrididæ, Locustidæ, and Gryllidæ have been examined; no living nymphs of members of the Mantidæ nor of winged Phasmidæ were studied. It is not probable, however, that these will present serious difficulties.

The most uniform characteristic of the wings of the four families studied is the structure of the anal area of the hind wings. For this reason we will begin our description of the tracheation of the wings with this area and proceed cephalad.

In the Orthoptera the anal area of the hind wings is broadly expanded and fanlike in form. The first anal trachea is simple (Figs. 74–78 *A*); the second and third anal tracheæ coalesce for a distance and then separate into several tracheæ, each of which traverses a convex vein of the fanlike portion of the wing. Sometimes, as in the wing of an Acridid, represented by Fig. 75, the common trunk of these two tracheæ divides into two large trunks, which probably correspond to the second and third

anal tracheæ respectively; but in most cases this division is not clearly indicated.

In many of the saltatorial Orthoptera the anal area of the hind wings bears a striking resemblance to the wings of Ephemerids, there being a regular alternation of convex and concave veins. In these cases the concave veins are evidently a later development than the convex veins. The increase in the number of the branches of the anal tracheæ takes place at the cau-

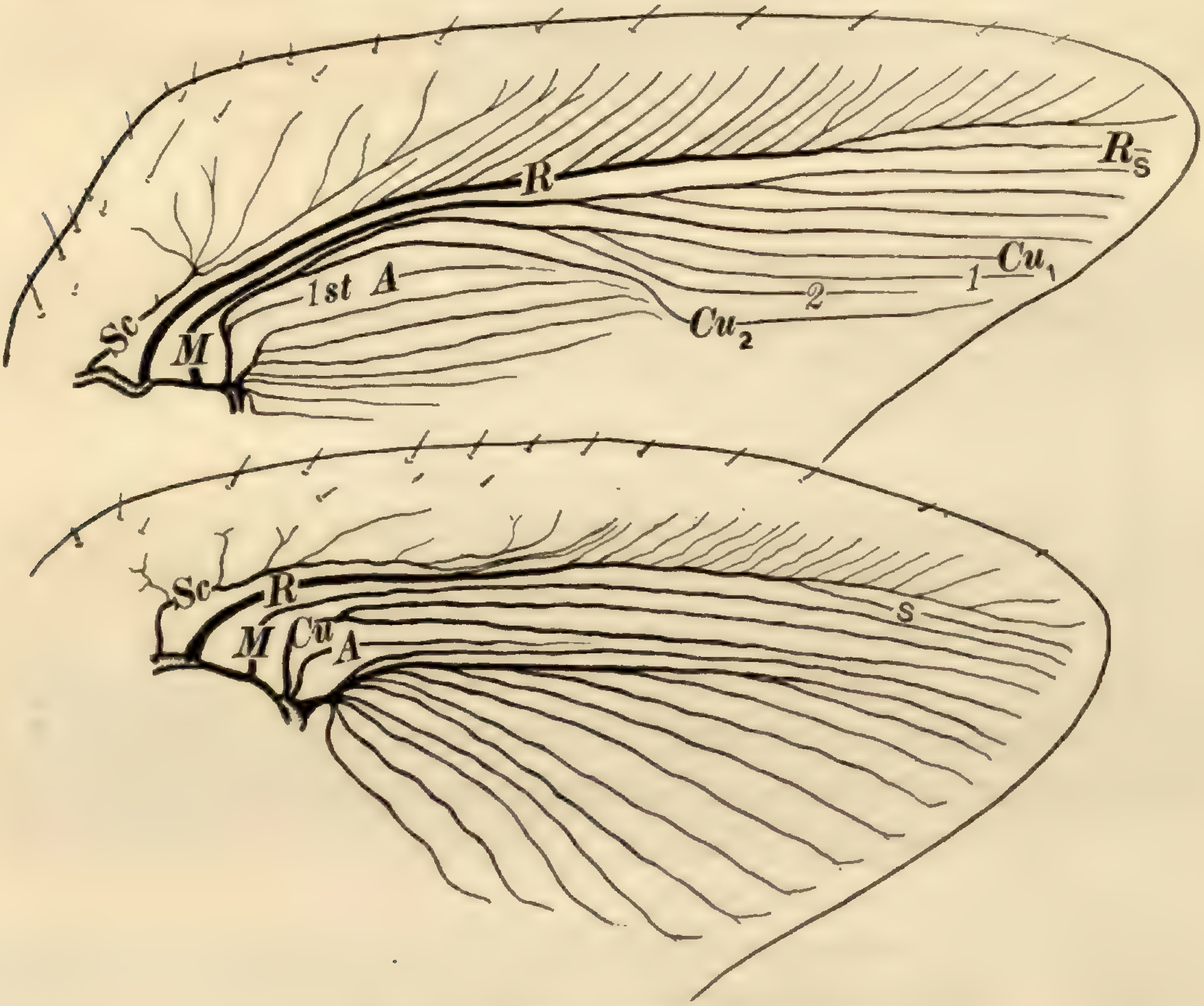

Fig. 74. — Wings of a nymph of a cockroach.

dal end of the series, and about each added trachea a convex vein is developed. It is only after the space between two of these convex veins becomes wide enough to admit of a fold in the wing that a concave vein is developed, and this development takes place in the same manner as in the Ephemerida. In some cases, as in the hind wings of Scudderia (Fig. 77), a tertiary set of anal veins is developed; these extend only a short distance from the margin of the wing, and increase the resemblance of this area to an Ephemerid wing.

The cubital trachea of the hind wings varies greatly in form, even within the limits of a single family. In the Acrididæ it is sometimes reduced to an unbranched condition (Fig. 75 *Cu*); in all of the Locustidæ known to us it retains the primitive two-branched condition (Fig. 76); in Œcanthus (Fig. 78) there is a single accessory cubital trachea; while in certain cockroaches, not figured here, vein Cu_1 is pectinately branched.

Similar variations in the number of branches of each of the other principal tracheæ of the hind wings occur. It is not

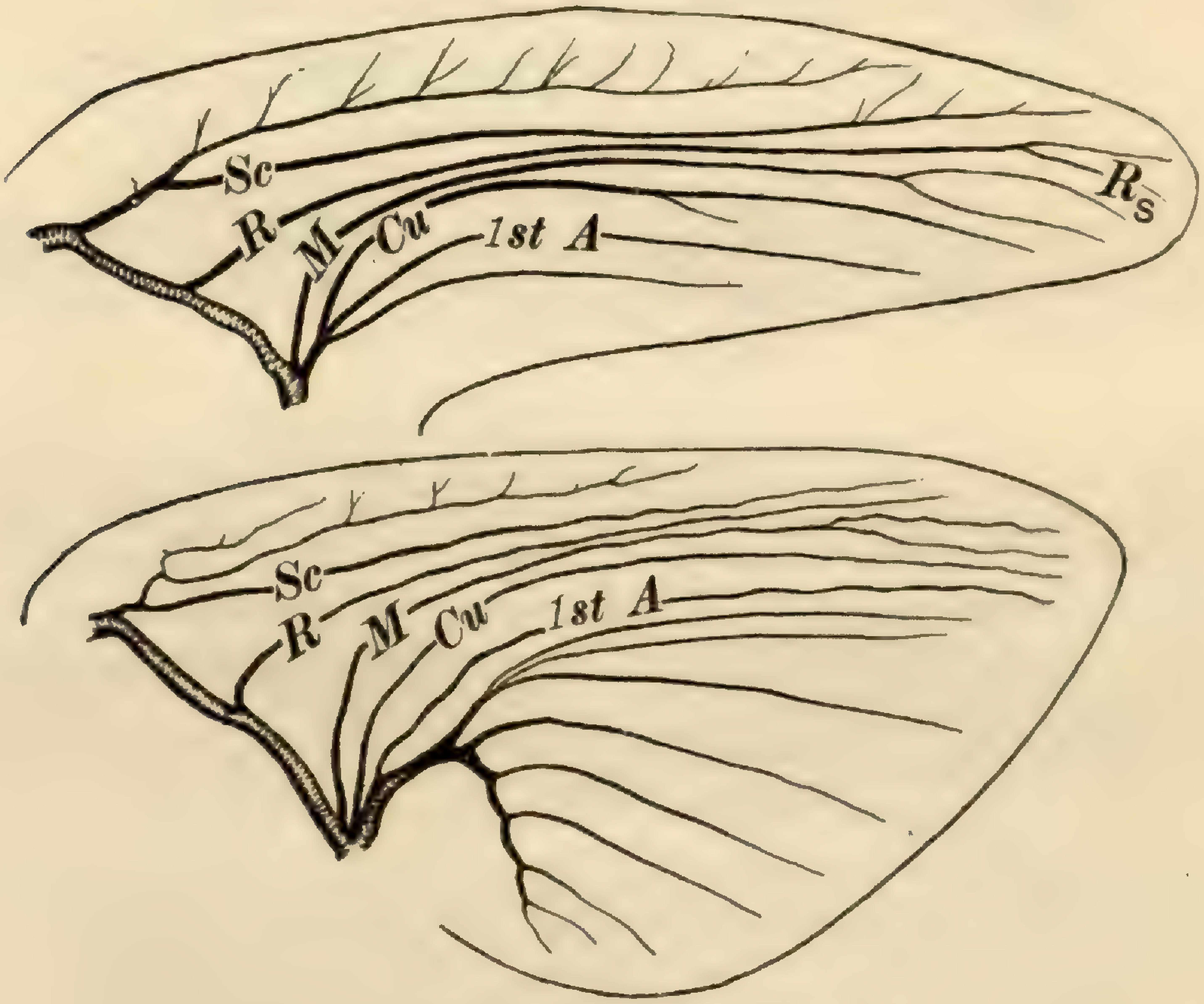

Fig. 75.— Wings of an Acridid nymph.

necessary to point them out in detail, as they are sufficiently indicated by the lettering of the figures. The most striking features are the reduction of the radius, the radial sector being at most unimportant, and in some cases entirely wanting, and the loss of the costal trachea.

In the fore wings the anal area is variously modified in the different members of the order. In the female Œcanthus (Fig. 78) it nearly retains its primitive form; in the Acridid,

represented by Fig. 75, a reduction of this area has taken place; while in the Blattidæ (Fig. 74) the three anal tracheæ are pre-

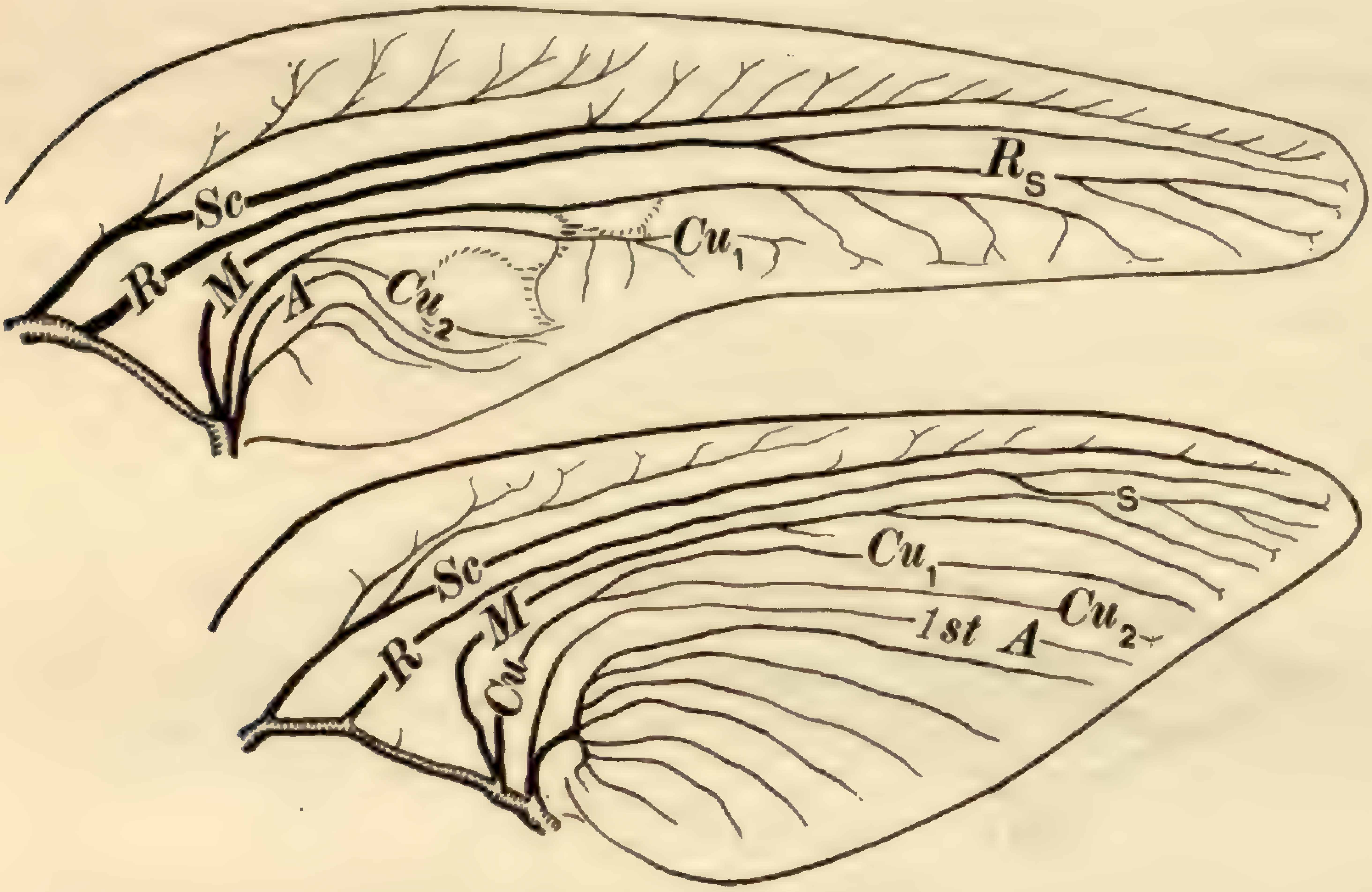

FIG. 76. — Wings of a nymph of Conocephalus.

served and the second and third have been specialized by addition, these tracheæ consisting of several parallel branches.

The cubital trachea is reduced to a nearly simple condition

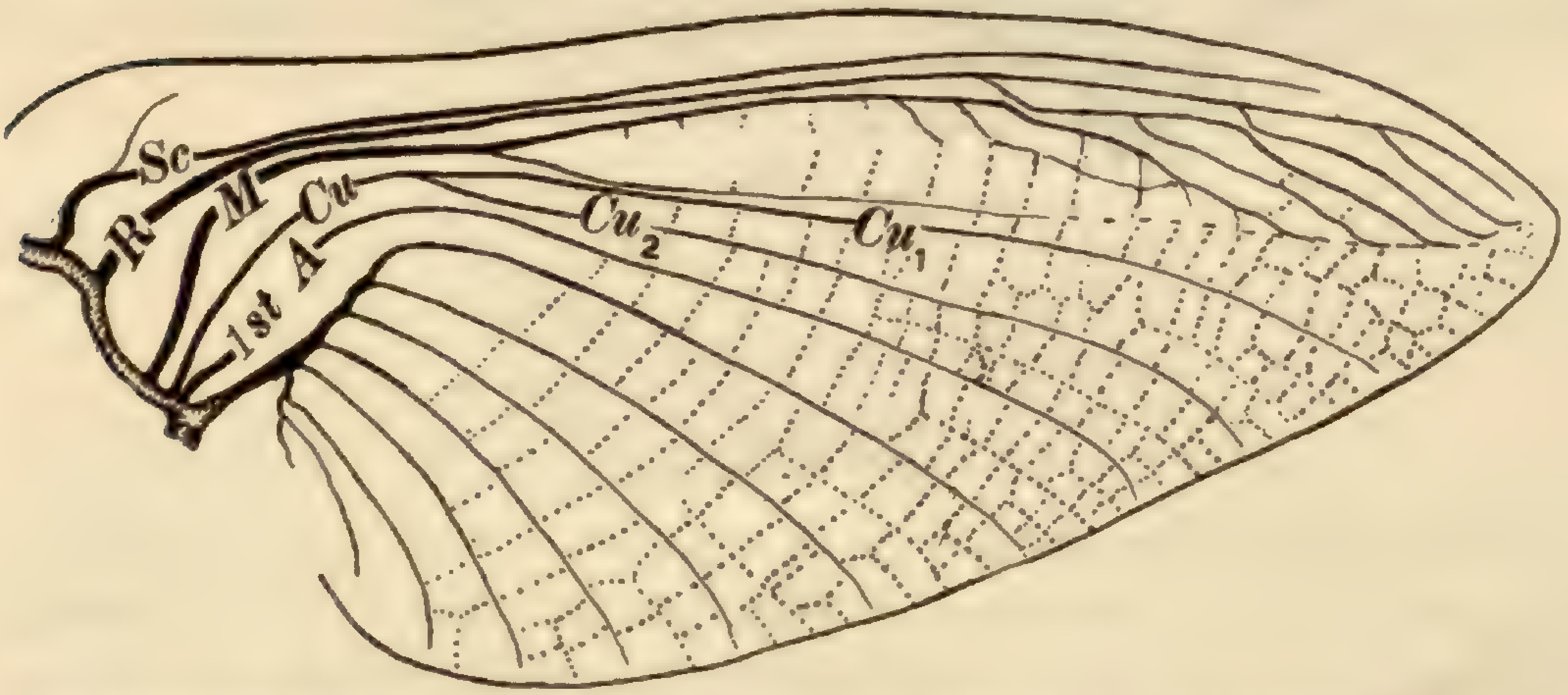

FIG. 77. — Hind wing of a nymph of Scudderia. Dotted lines indicate adult venation in part.

in the Acridid (Fig. 75); but in the other forms examined accessory tracheæ are developed on the caudal side of trachea Cu_1.

In the males of the Locustidæ (Fig. 76) and of the Gryllidæ (Fig. 79) the formation of a musical organ has been attained

by a modification of the cubital and anal areas. An extreme case of this is furnished by the male Œcanthus (Fig. 79). The principal vibrating area of the wing lies between the branches of the cubitus, which diverge widely in this sex.

A study of the musical organs of adult Orthoptera throws light on the nature of the anal furrow. In the female this furrow lies between the cubitus and the first anal vein; but in the males of the Locustidæ and Gryllidæ the anal furrow crosses

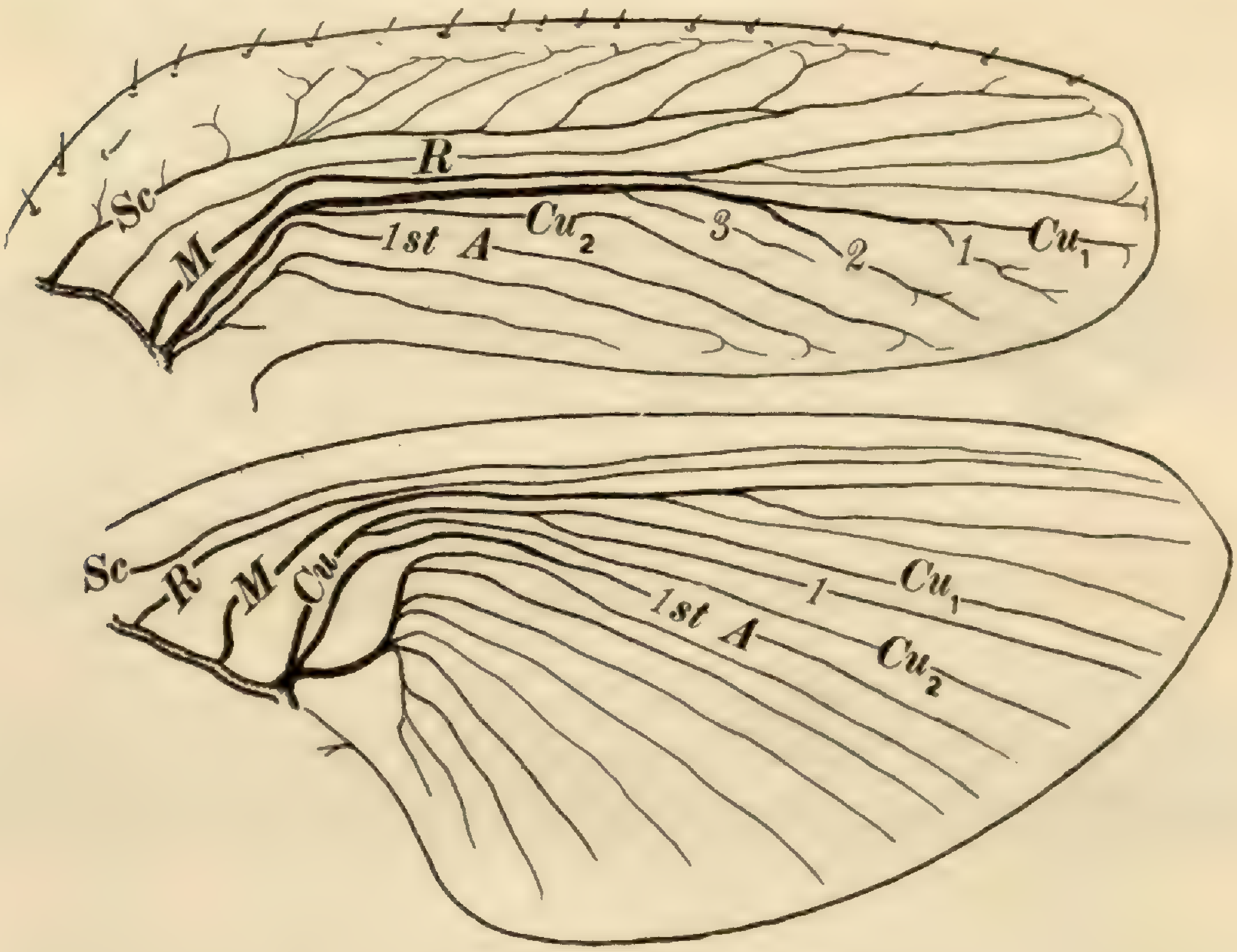

FIG. 78. — Wings of a female nymph of Œcanthus.

vein Cu_2. It is evident, therefore, that this furrow is merely a fold in the adult wing, and that its position is variable. It has already been shown[1] that in the Heteroptera, when an anal furrow is developed, it is in front of the cubitus, instead of in the more usual position between the cubitus and the first anal vein.

Although the wings of the two sexes of Œcanthus present a very different appearance, there is really a very close correspondence in the tracheation (and consequently in the vena-

[1] *American Naturalist*, vol. xxxii, p. 252.

tion) of the two, as can be seen by comparing the lettering of Figs. 78, 79; the same number of anal veins and of accessory cubital veins exist in the two sexes.

The lettering of the figures will serve to show the striking differences in the development of the remaining veins in different members of the order. Thus, for example, while the radius is the most prominent vein in the fore wing of the cockroach (Fig. 74), in Œcanthus (Figs. 78, 79) it is the least developed

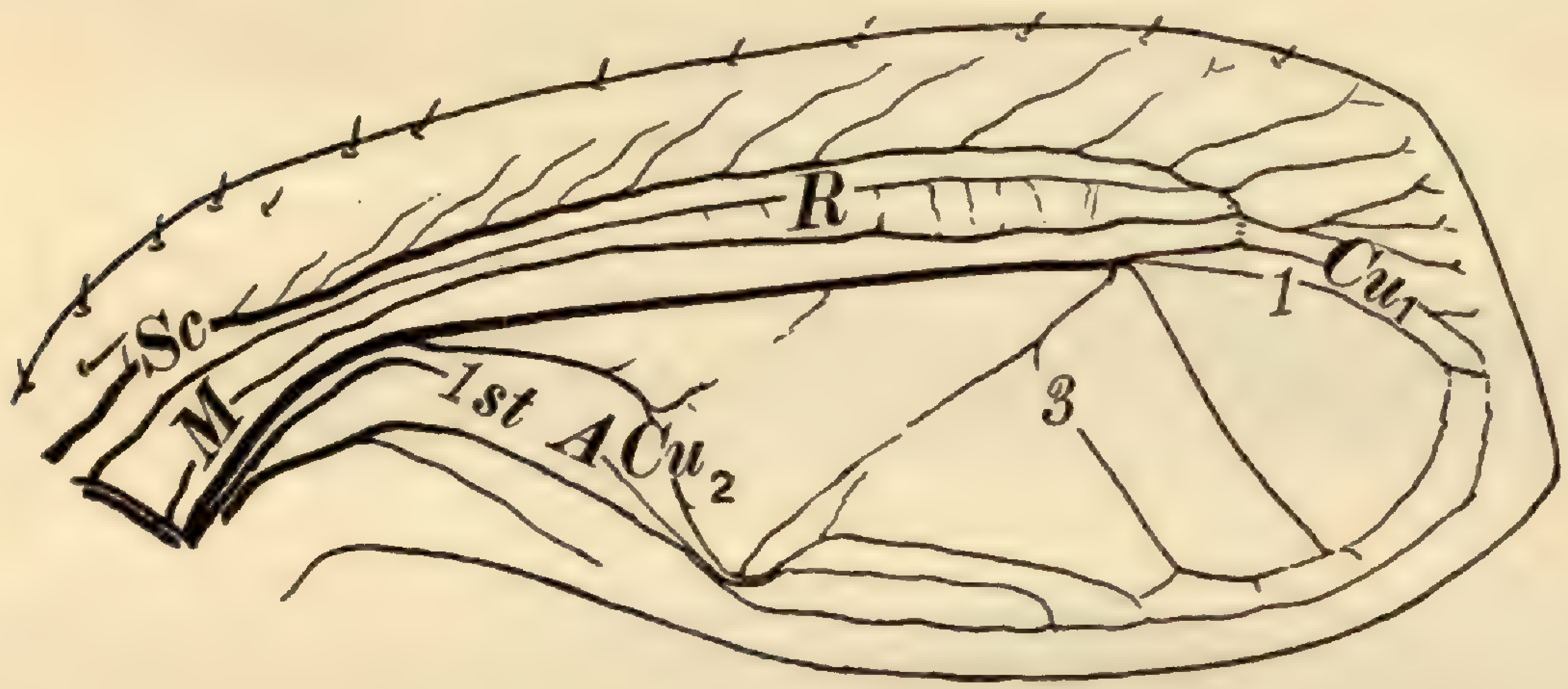

FIG. 79. — Fore wing of a male nymph of Œcanthus.

of the principal veins; or, to take another example, the subcosta is greatly reduced in the cockroach (Fig. 74), while in the Acridid (Fig. 75) and in the Locustid (Fig. 76) it is as well developed as any other vein.

In none of the Orthoptera that we have examined is the costal trachea distinctly preserved. Frequently, as in the Acridid (Fig. 75) and in the Locustid (Fig. 76), there is a prominent branch of the subcostal trachea which simulates a costal trachea; but that this is merely an overgrown branch of the subcostal trachea is evident when a series of forms are studied; in the hind wing of Conocephalus (Fig. 76) there are two such branches.

It will be remembered that in our hypothetical type the subcosta is two-branched, and that the branches are designated as Sc_1 and Sc_2 respectively. A good example of this typical branching of the subcosta is afforded by Nemoura.[1] But there

[1] *American Naturalist*, vol. xxxii, p. 238, Fig. 8.

are no indications that the primitive branching has been retained in the Orthoptera; here, when the two-branched condition exists, it is a secondary development; it would be misleading, therefore, to designate these branches as Sc_1 and Sc_2, for they do not correspond to the branches so designated in other orders. In this case the branch, or branches, of the subcostal trachea are merely accessory branches, like the accessory branches developed on other principal tracheæ.

Although the costal trachea has been lost, the thickening of the costal margin of the wing should be called the costal vein; for it is still the vein that was formed about the costal trachea in the beginning.

The few illustrations given here will show how easily the homologies of the tracheæ of the wings of orthopterous nymphs, and consequently of the veins that are formed about them, can be determined. But if one studies only the wings of adults, where many cross-veins have been developed, and where the basal connections of the principal veins are obscured, it is extremely difficult to determine these homologies. It is also evident that the wings of these insects present many characters which are easily available for taxonomic purposes.

The Position of the Orthoptera in the Class Insecta as indicated by the Tracheation of the Wings. — The making of genealogical trees does not fall within the scope of the present series of papers. Our object has been to learn in what ways wings have been modified in order to determine the homologies of the wing-veins. It is obvious that this had to be done before the characters presented by the wings could be used intelligently in working out the phylogeny of the orders. Now that this has been accomplished, it would be possible to propose a provisional classification of insects based on the characters of the wings; but we feel that it is much better to wait till the results we have attained can be correlated with similar studies of other organs. There is, however, one character in the tracheation of the wings to which it seems worth while to call attention now.

In most insects the principal tracheæ of the wings form two quite distinct groups. These we have already designated as the

costo-radial and the cubito-anal groups respectively.[1] To the former belong the costa, the subcosta, and the radius; to the latter, the cubitus and the anal veins. These groups find their attachment to the main tracheal system of the body at points wide apart; in the Perlid genus, Capnia, the former group springs from the dorsal lateral trunk, the latter from ventral lateral trunk of the thorax.[2] Even in such groups as Trichoptera, Hymenoptera, and Diptera, where great reduction has taken place, the persisting tracheæ clearly represent these two groups.

The media is sometimes a member of the costo-radial group (Fig. 80) and sometimes of the cubito-anal group (Fig. 76). In

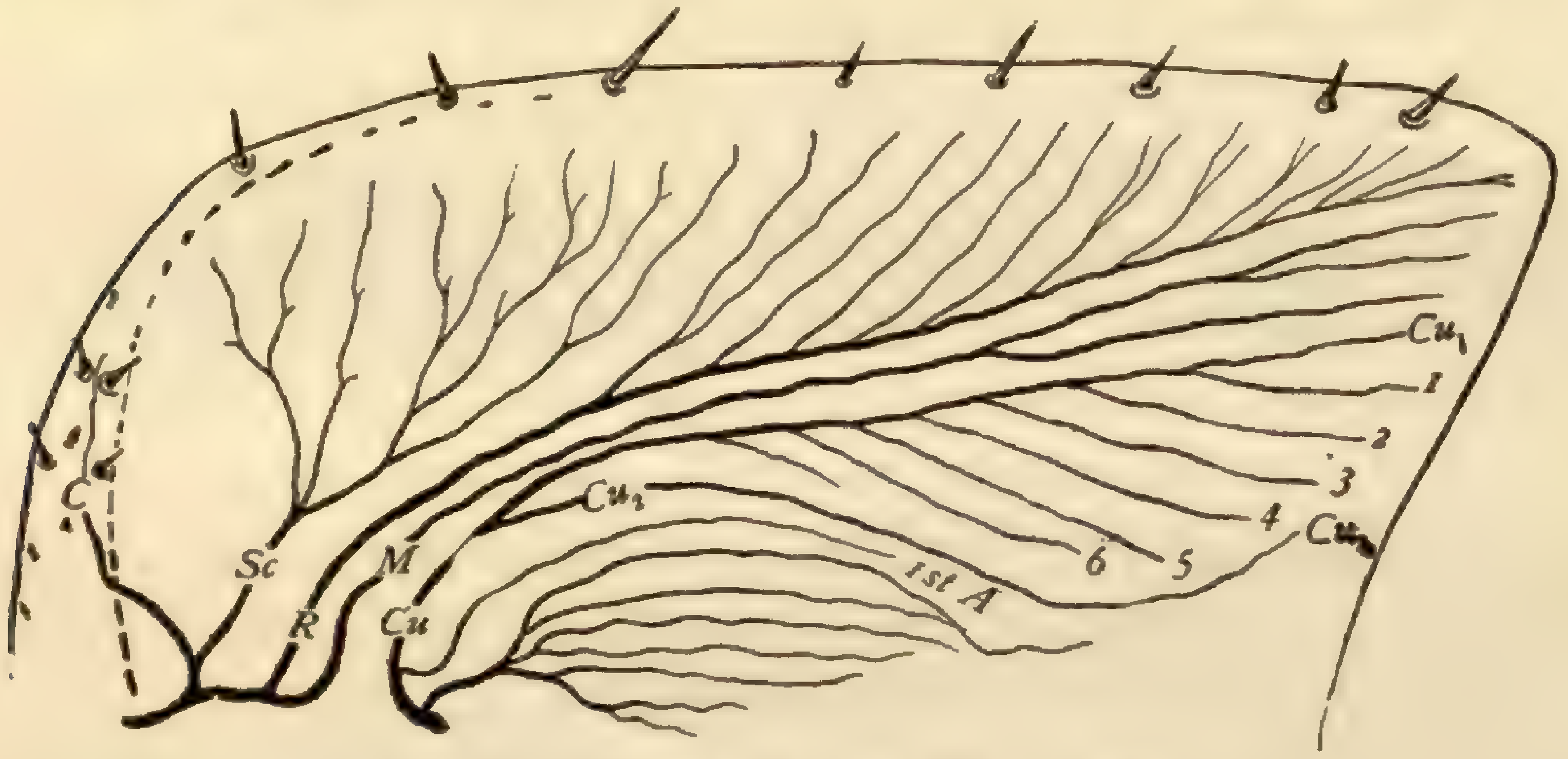

FIG. 80. — Fore wing of a nymph of a cockroach.

certain forms, however, the media arises midway between these two groups from a transverse basal trachea which joins them, suggesting at once the possibility of its migration from one group to the other. Since there is no evidence of its having entered the wing independently, to which of the two groups did it belong in the primitive winged insect? The answer lies (1) in the rank of the insects showing the different conditions, and (2) in the ontogeny of the media itself.

(1) Only in the Plecoptera and in some of the Blattidæ does the media clearly belong to the costo-radial group, and in these there is no basal transverse trachea connecting the two groups;

[1] *American Naturalist,* vol. xxxii, p. 88.

[2] A fact of no little interest in its relation to the question of a former respiratory function in these or closely related parts; since tracheal gills are commonly joined to both longitudinal lateral trunks, securing, doubtless, better distribution of the air.

in all other insects we have studied, the two groups are connected and the media is either joined to the cubito-anal group or arises from the transverse basal trachea. No one will hesitate to believe that the Plecoptera and the Blattidæ are the ones more likely to have retained the more primitive structure.

(2) We have previously shown[1] that in a Cicada nymph one-third grown the medial trachea springs from the transverse basal trachea midway between the radial and the cubital tracheæ, while in the grown nymph it has reached the cubital trachea. In most insects of which we have had nymphs of various ages we have observed the same direction of migration; never any migration in the opposite direction.

From this it follows that, in arranging the orders of winged insects in an ascending series, if we take into account only the structure of the wings, the Plecoptera should be placed first; for this order, as a whole, retains the primitive condition of the basal connections of the wing tracheæ. Next to this in degree of divergence from the primitive wing type stand the Orthoptera, with the Blattidæ the lowest of the series of orthopterous families; for in this family alone is the primitive condition of the basal connections of the wing tracheæ retained.

In this connection attention should be called to the striking similarity of the anal area of the hind wings in the Orthoptera and in the Plecoptera; in both cases the fanlike portion is supported by the second and third anal veins, while the first anal vein remains simple.

An understanding of the nature of the changes that are taking place in the basal connections of the wing tracheæ renders this region of the wing a very instructive one. Let us examine again the figures herewith given: In the wing of a cockroach, represented by Fig. 80, the primitive type is retained, the medial trachea is a member of the costo-radial group, and there is no transverse basal trachea; while in the wings represented by Fig. 74 the basal trachea is well developed, and the medial trachea has begun its migration toward the cubito-anal group, but it still arises from the basal trachea. In all other forms here figured the base of the medial trachea has nearly or quite

[1] *American Naturalist*, vol. xxxii, p. 249.

reached the cubital trachea and usually coalesces to a greater or less extent with it. An extreme case of this migration is illustrated by Xiphidium (Fig. 81). And here there appears to be a reduction of the transverse basal trachea. It has served its purpose, and, like an abandoned road, is disappearing from view. It will not be surprising if Locustid nymphs are found

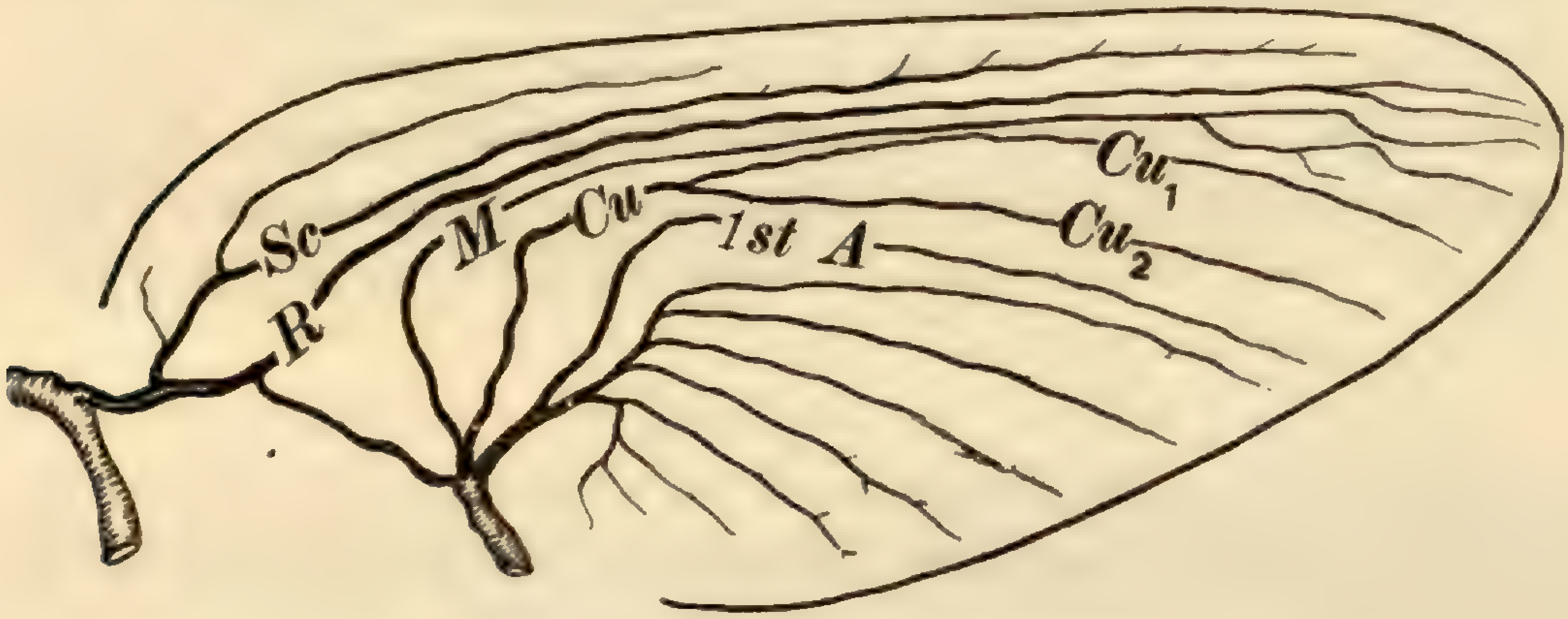

FIG. 81. — Hind wing of a nymph of Xiphidium.

in which this connection between the two groups is lost, but the presence of the medial trachea in the cubito-anal group will show it to have existed.

In the Acridid, represented by Fig. 75, the radial trachea is following the medial in its migration; this is indicated well by the curve near the base of the radial trachea in the hind wing.

VI. Conclusion of Chapter IV.

In this and the preceding chapter we have furnished data for determining the homologies of the veins in each of the orders of winged insects except the Euplexoptera, Mecaptera, Isoptera, and the Physopoda. Of the first two we have been unable to procure immature stages; it is not probable, however, that they will present serious difficulties when they are studied. Of the Isoptera we have examined nymphs of two genera, Termes and Termopsis, but we wish to examine other forms before publishing conclusions. In all of the Physopoda that we have seen, the tracheation of the wings is so reduced that we have been unable to determine definitely the homologies of the few remaining tracheæ. We therefore close at this point our discussion of this phase of the subject and pass to a study of the beginning of wings.

ON NEW FACTS LATELY PRESENTED IN OPPOSITION TO THE HYPOTHESIS OF BIPOLARITY OF MARINE FAUNAS.

ARNOLD E. ORTMANN.

Bipolarity in the distribution of marine animals, indicated by Théel as early as 1886, has been proposed as a theory by G. Pfeffer.[1] Later, J. Murray[2] accepted the theory and tried to support it by a careful collection of facts. From the beginning the present writer, chiefly relying on the investigation of the distribution of decapod crustaceans, vigorously objected to the theory, and expressed his views as early as 1894 and 1895,[3] contending that the cases introduced by Pfeffer were not correct. In 1896, after the publication of Murray's paper, the writer published an article[4] dealing with the subject more closely, and arrived at the conclusion that bipolarity does not exist as a general law of distribution among the decapod crustaceans, and that it seems very improbable that such a law may prevail among other groups of animals.

J. Murray disregarded these objections, and on different occasions[5] continued advancing bipolarity as a distributional fact, which called forth repeated objections on the part of the writer.[6] Since then (1897) other zoölogists have taken part in

[1] *Versuch über die erdgeschichtliche Entwicklung der jetzigen Verbreitungsverhältnisse unserer Thierwelt*, p. 38. Hamburg, 1891.

[2] *Trans. Roy. Soc. Edinburgh*, vol. xxxviii (1896), No. 2, p. 494.

[3] *Jenaische Denkschr.*, Bd. viii (1894), p. 76, and *Grundzüge der marinen Thiergeographie*, p. 52. (This latter book was issued in December, 1895, but bears the date 1896 on the title-page.)

[4] *Zool. Jahrb., Syst.*, Bd. ix (1896), pp. 571 *ff.*

[5] *Nature*, vol. lv (1897), No. 1430, p. 500, and in *The Geograph. Journ.*, vol. xii (1898), No. 2.

[6] *Zool. Jahrb., Syst.*, Bd. x (1897), p. 217, and *Science*, vol. viii (1898), p. 516. Pfeffer (*Zool. Anzeig.*, Bd. xx, September, 1897) has referred to the first of these objections; but since he does not discuss the matter at all, and only doubts the ability of the writer to investigate this topic, it is better not to consider this note.

the discussion, and at present we possess the results of a number of investigations in special groups of animals, dealing with the relations of the Arctic and Antarctic faunas. All the results obtained tend to show that the original contention of the writer, derived from a study of the decapods, is fully supported by the facts found among other groups, so that the theory held by Pfeffer and Murray, that both polar faunas are more closely related to each other than to any of the intermediate ones, is without support. In fact, there have been added very few cases of bipolarity of genera to the single case established by the writer in 1895,[1] and one case of a bipolar species, discovered by Chun, is to be looked upon with some suspicion, for he himself suggests an explanation. All this points to the confirmation of the opinion of the writer, that, although some cases of bipolarity may exist, such cases are extremely rare, and may be explained in one of the ways indicated in his paper of 1896, while the greater part of each polar fauna consists of peculiar forms, which show no closer connection with each other than with forms found in tropical latitudes.

We will now review the chief results of the papers recently published, and then draw conclusions as to the theory of bipolarity. However, it is well to observe that some of the authors referred to did not give all the necessary data. Especially is there a lack of information as to the distribution of genera found in both polar seas, outside of their polar range. The writer has tried to supply this deficiency by consulting other papers, but as he cannot claim to be a specialist in the respective groups, he has in some cases failed. Further, a misunderstanding seems to exist on the part of some authors as regards the term "bipolarity"; they sometimes call a species or genus that is found in both polar areas bipolar, although it is also present in intermediate localities. But "bipolarity," as understood by Pfeffer and Murray and the present writer, implies that a bipolar form is wanting in the intermediate tropical parts of the seas, and the chief difficulty in the discussion is the explanation of such cases of *discontinuity* in distribution.

The first paper to be discussed is an investigation of the

[1] *Proc. Acad. Philad.* (1895), pp. 189–197.

pelagic faunas of the Arctic and Antarctic, by C. Chun.[1] He collects the records of the occurrence of the animals constituting the plankton of the polar regions (Protozoa, Medusæ, worms, crustaceans, mollusks, Tunicata, and fishes), and although he complains in many cases of a general lack of information, especially as to the Antarctic pelagic life, he reaches some very important conclusions. He recognizes a general similarity of both faunas, which finds its chief expression in the prevalence of certain groups in both areas and the absence of others; and, further, he mentions the presence in both polar seas of two identical species, one a worm (*Sagitta hamata*), the other a Tunicata (*Fritillaria borealis*). The first case, that of *Sagitta hamata*, is treated more in detail, and Chun shows (after Steinhaus and Lohmann) that this species, which has been found near the surface in both polar seas, crosses the Atlantic Ocean. It is not, however, found there near the surface, but at considerable depths (300–1500 m.). Thus, for this pelagic species, a connection of the Arctic and Antarctic range through the tropics, but in deeper water, is established (analogous to the connection of littoral polar forms along the bottom of the deep sea), and Chun concludes that this connection, once having been proved, is sufficient to explain other cases, and that there is no need to have recourse to theories which, like Pfeffer's and Murray's, go back to former climatic conditions of the earth. Yet in the writer's opinion this conclusion is not satisfactory. We do not want to know how an individual case *may* be explained, but we want to know how it can be explained *correctly*. Although we must appreciate the value of the case represented by *Sagitta hamata*, still there remains the question to be settled, whether other cases of bipolarity, which may be discovered, are really cases of bipolarity, where there is no connection of both ranges, and whether such cases are to be explained by the Pfeffer-Murray theory, or by other means, as indicated by the present writer. But at any rate Chun's paper shows plainly that cases of bipolarity among pelagic organisms seem to be *very rare*.

[1] *Die Beziehungen zwischen dem arktischen und antarktischen Plankton.* Stuttgart, 1897.

All the other papers under consideration discuss littoral and abyssal animals. In an article on the history of the marine fauna of Patagonia, H. von Ihering[1] compares the Antarctic mollusks with those of the Arctic. He mentions 9 species that are found in both polar seas, but at the same time he says that this list comprises almost exclusively such species as are of a very large or universal distribution. The connection of the polar localities of these forms is chiefly through the deep sea. There are no true bipolar *species*, and if we regard the *genera* present or wanting in the Arctic and Antarctic molluscan faunas, both differ considerably.

Breitfuss[2] has published a study of the distribution of the calcareous sponges of the Arctic seas, and incidentally compares them with those of the Antarctic. Of 42 Arctic species only a few (6) cross the equator, and a single one extends its range into the southern polar regions (*Grantia capillosa*). The rich Calcispongiæ fauna of the Australian and New Zealand coasts is very distinct from that of the Arctic, and from the Magellan, South Georgian, and Kerguelen regions only 6 species (belonging to 4 genera) are known, which, with the exception of *Grantia capillosa*, are different from the northern species; and of these genera one (Leucetta) is missing in the Arctic Ocean, while, on the other hand, numerous Arctic genera (6 out of 11) are not known from the Antarctic. No case of bipolarity, either of a species or genus, is mentioned, and the author says nothing about a resemblance of faunas of both seas.

Herdman[3] refers to the extra-tropical southern tunicate fauna of Australia, and, without going into further detail, states that there is no special relationship between it and the tunicate fauna of the northern hemisphere. As to Murray's extracts, from his report on the distribution of the Challenger-Tunicata, he says that the distributional data given in this report are not complete, and, he says, "have to be added

[1] Zur Geschichte der marinen Fauna von Patagonien, *Zool. Anzeig.*, Bd. xxvii, December, 1897.

[2] Die arctische Kalkschwammfauna, *Arch. f. Naturg.*, Bd. i (1898), Heft 3.

[3] *Ann. Mag. Nat. Hist.*, Ser. 7, vol. i (1898), and *Trans. Liverpool Biol. Soc.*, vol. xii (1898), p. 251.

to or modified in such a way as to entirely change the nature of their evidence, and show that there is no such close resemblance between the northern and southern polar faunas as Dr. Murray and others have supposed." In fact, he states plainly that among the simple ascidians no cases of bipolarity are known.

D'Arcy W. Thompson[1] has reëxamined the list of bipolar animals given by J. Murray. This list contains nearly 100 species, but d'Arcy W. Thompson shows (p. 347) that there are among them "more than one-third in which grave doubt as to their identification was expressed by the original describers, or in which the identification has been doubted or denied by later writers. In somewhat more than another third the evidence of identity is inconclusive or even inadmissible by reason of the nature of the examination to which the specimens were subjected, or by reason of the small size of the objects and lack of adequate marks of characterization. Of the remaining forms, about a dozen find their northern representatives in the Japanese seas, where they form part of a fauna predominantly southern in its relations, and where at least the occurrence of any particular form cannot be taken, *ipso facto*, as evidence of a boreal center of distribution."

After deducting these forms the list shrinks into very little. There remains, aside from 12 deep-sea species, only a single littoral annelid species (*Terrebellides strœmii*), and 2 pelagic species, a mollusk, *Janthina rotundata*, and a copepod, *Calanus finmarchicus;* but even these last two hardly seem to be bipolar, since neither of them is recorded from further south than 35° S. L., and the latter seems to be rather a cosmopolitan form (see note on p. 349, *loc. cit.*).

Further, d'Arcy W. Thompson gives an examination of the Antarctic fishes, isopods, and amphipods, with special reference to bipolarity. He finds no species in any of these groups to inhabit both the Arctic and Antarctic Oceans, and he sees no signs of a likeness of both faunas.

A valuable series of monographs has been published by

[1] On a Supposed Resemblance between the Marine Faunas of the Arctic and Antarctic Regions, *Proc. Roy. Soc. Edinburgh* (1898), pp. 311–349.

H. Ludwig,[1] treating of the distribution of the holothurioids, crinoids, and ophiuroids, with special reference to their polar ranges. The part on the holothurians is especially interesting, since it was this group that first suggested to Théel the idea of bipolarity. According to Ludwig there are no bipolar species, and, in respect to the genera, there is not a single instance that shows the slightest indications of bipolarity. Out of 10 genera found in both polar regions, 5 (Stichopus, Cucumaria, Thyone, Phyllophorus, Chirodota) have been found abundantly in the littoral parts of the tropics, and 4 (Bathyplotes, Mesothuria, Trochostoma, Ankyroderma) are connected in the deep sea; and the same seems to be true of Psolus, which has been reported from tropical latitudes, although it seems to be rarer there. Aside from these 10 genera mentioned, there are 9 genera peculiar to the Antarctic, and 6 peculiar to the Arctic (but some of them extend into the tropics), thus giving a different character to the two faunas. The general result in the other two groups studied by Ludwig is practically the same; there are no bipolar species, and the number of genera peculiar to each fauna is larger than the number of genera common to both. Among the crinoids there is only 1 genus (Antedon) found in both areas, while 3 are peculiar to the Antarctic (2 of them abyssal) and 1 peculiar to the Arctic, and among the ophiuroids 6 genera are common to both areas, while 9 are peculiar to the Antarctic and 8 to the Arctic.

The genus Antedon found in both polar seas is very interesting. Both the Antarctic and Arctic species belong exclusively to two sections of the genus, *A. eschrichti* and *A. tenella.* The Tenella group is found in all parts of the world, so that there is nothing remarkable about its distribution. The Eschrichti group, however, contains 4 littoral Antarctic species and 3 littoral Arctic species (2 of them also abyssal), the latter all from the North Atlantic. Now it is very significant that some kind of a connection is afforded by one of the Antarctic species, namely, *A. rhomboidea.* This species has been found in the littoral of the southern end of America, and its range extends northward

[1] *Hamburger Magalhaensische Sammelreise.* Holothurien, 1898; Crinoideen, 1899; Ophiuroideen, 1899.

along the western coast of America to 22° N. L., but there it has been dredged at greater depths (1200–1400 m.). Although no species of this group has yet been found in the northern Pacific, it is very probable, nevertheless, that such species do exist. In that case we would here have again an instance of a connection, along the western coast of America, of an apparently bipolar group of marine animals. Examples of this kind have been pointed out, by the present writer, among the decapods.

Of the 6 ophiuroid genera common to both the polar seas, 4 (Ophioglypha, Ophiactis, Amphiura, Ophiacantha) are also represented in the littoral of the tropics. The 2 remaining genera (Ophiocten, Gorgonocephalus) are chiefly abyssal genera, and, as far as the writer could determine, Ludwig does not give any information — at least, Ophiocten is also found in tropical latitudes.

Thus in these three groups we have again the same result: that bipolarity, if present at all, is extremely rare, and that the most prominent feature of the respective faunas of the polar seas consists in their dissimilarity.

Yet Ludwig calls attention to a certain general likeness of both faunas, expressed by the mutual prevalence of certain genera and the mutual lack of others as compared with the tropic faunas. This is not to be regarded at all as a remarkable fact, and has no connection with the question under discussion; indeed, it would be very strange if other conditions prevailed. When, out of a number of genera present in the tropics, a certain number disappears as we approach either pole, while a certain number does not, this shows only that the latter are not affected by the change of conditions, — chiefly climatic, — while the former are, and of course by the disappearance of a number of types the percentage of the remaining must increase, if the deficiency is not made up by other genera making their appearance in the colder regions. This is again an instance where statistics give a wrong idea of the true conditions; the increase of the percentage of certain genera in the polar seas is not due to an actual increase of species and a more vigorous development, but only to the lack of species of other genera.

Lastly, we have a paper, by O. Buerger,[1] treating of a group of worms, the nemertines. Buerger does not go much into detail, but we must attribute this chiefly to our scant knowledge of this group. Again, there are no bipolar species; the only two species which have been found in corresponding latitudes on both hemispheres are circum-tropical, and enter extra-tropical parts only on the northern and southern limits of their range. As regards the genera, all Antarctic genera (9) are also found in the Arctic. Buerger says that a general similarity of both polar faunas is thus indicated, but the lack of 12 Arctic genera in the Antarctic does not support this view; and since he says, further, that neither of the faunas seems to possess very characteristic types, as do the tropics, it is evident that these 9 genera common to both polar faunas are also represented in the tropics. There is, however, one genus that seems to be bipolar; Carinoma, which has been found on the coast of England (*C. armandi*) and in the Straits of Magellan (*C. patagonica*).

There is no doubt that the facts presented here do not at all support the theory of bipolarity. The contention of Pfeffer and Murray is that bipolarity forms a very striking feature of the polar faunas. This has been denied by the present writer with regard to the decapod crustaceans, and now von Ihering has confirmed this latter opinion for the mollusks, Breitfuss for the Calcispongiæ, Herdman for the tunicates, d'Arcy W. Thompson for the fishes, isopods, and amphipods, Ludwig for the holothurians, crinoids, and ophiuroids, Buerger for the nemertines, and Chun for the entire bulk of the pelagic fauna.

Two cases of bipolarity of species and one of genera have been discovered, and when we add these to the single case previously established (Crangon), we have altogether four cases of true bipolarity which are to be explained by a theory. In all other cases the supposed bipolar range of a species or group has been connected by intermediate localities, and these connections are of two kinds: (1) connection along the bottom of the deep sea or in deeper strata of the tropical parts of the open

[1] *Hamburger Magalhaensische Sammelreise.* Nemertinen, 1899.

sea (Ortmann, von Ihering, Thompson, Chun, Ludwig); (2) connection along the western shores of the continents, mostly connected with a descending of the respective forms into deeper water (Ortmann, Bouvier, Thompson, Ludwig).

It is possible that by these ways cases of true bipolarity may develop, provided these connections become discontinued. The writer has explained a true case of bipolarity (Crangon) by one of these ways. But, on the other hand, it is also possible that bipolarity is to be explained by the Pfeffer-Murray theory in some cases by former conditions of the earth's history, especially those existing at the beginning of the Tertiary period. Yet we do not know any concrete case of this kind, and we must wait for further investigation to show whether bipolarity as a *relic* of older times is realized in the geographical distribution of any marine animals.

SYNOPSES OF NORTH-AMERICAN INVERTEBRATES.

I. Fresh-Water Bryozoa.

C. B. DAVENPORT.

These minute animals are found very abundantly in ponds and streams. Upon the underside of floating boards or of fallen tree trunks, in quiet pools or ponds, one may find the branching Plumatellas and Fredericella; upon rocks one often finds the *Plumatella punctata* in crowded masses. In pond-bottoms or in slow-moving streams Cristatella may be found on leaves of aquatic plants or bottom *débris*. More rapid streams afford Paludicella and Pottsiella. Below milldams, where the waters are turbulent, Urnatella and Pottsiella have been found together on stones. In reservoirs near where the waters are being pumped in, or on the gates of milldams, one may look for Pectinatella. Since all species form colonies by budding, compounds of Bryozoa may be formed of great size. Some of the Plumatella colonies stretch over a plain surface six inches in diameter, and a Pectinatella colony may become by the end of summer a sphere two feet or more in diameter. Bryozoa prefer the shade, and hence are more apt to occur in places not directly illumined by the sun's rays.

Fresh-water Bryozoa pass the winter in an inactive stage. The Phylactolæmata produce little seed-like bodies called statoblasts. These may be found as minute brown bodies floating on the surface of ponds in the winter and spring. If some of these are brought indoors in the early spring, they will hatch out after a few days, revealing a double embryo, which is one of the most beautiful objects for microscopic observation. The food of fresh-water Bryozoa consists of minute plants suspended in the water, such as diatoms.

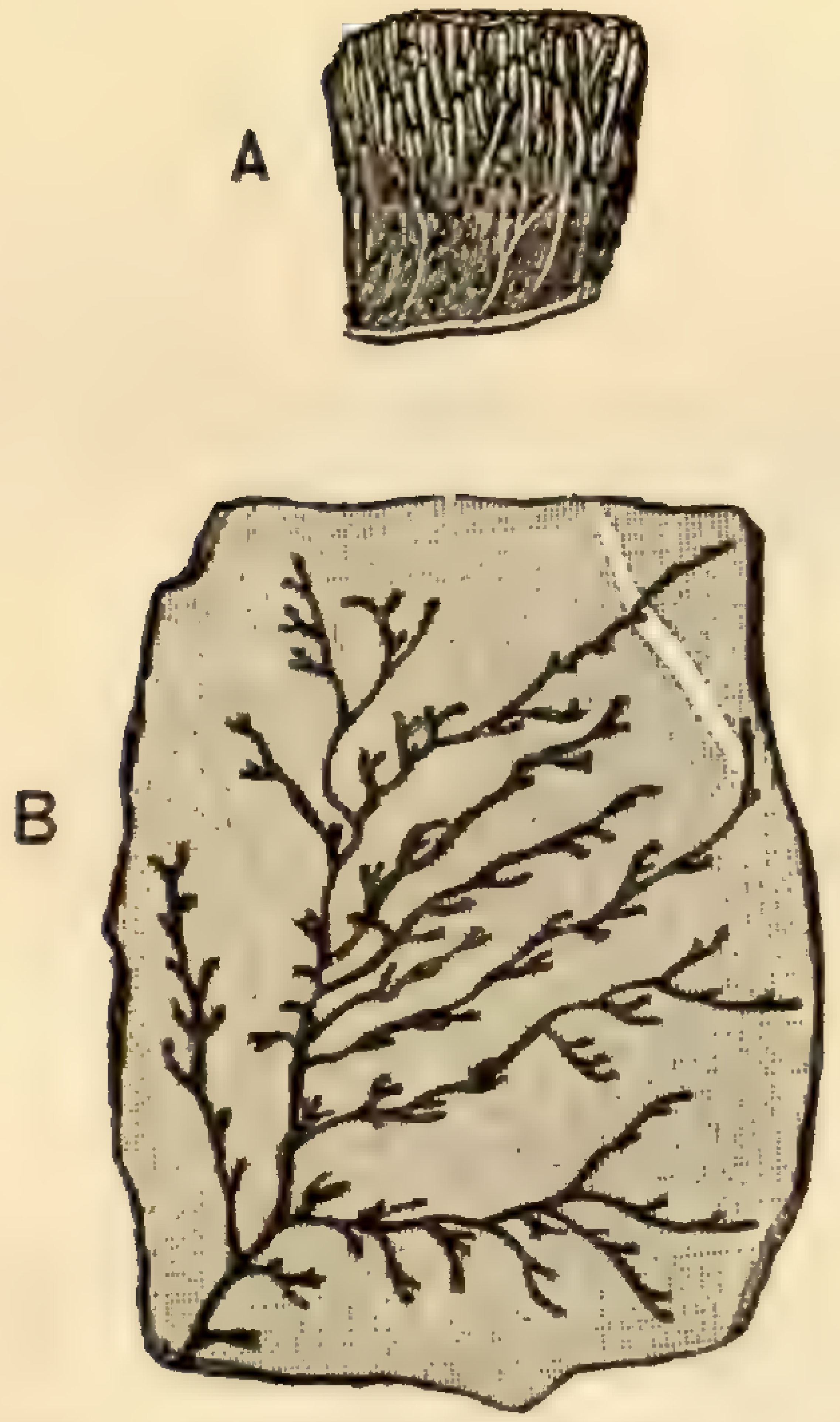

Fig. 1. — A, *Plumatella polymorpha*, var. fungosa, small part of mass, natural size. B, *Plumatella polymorpha*, var. repens, on leaf of water lily, natural size. From Cambridge Natural History.

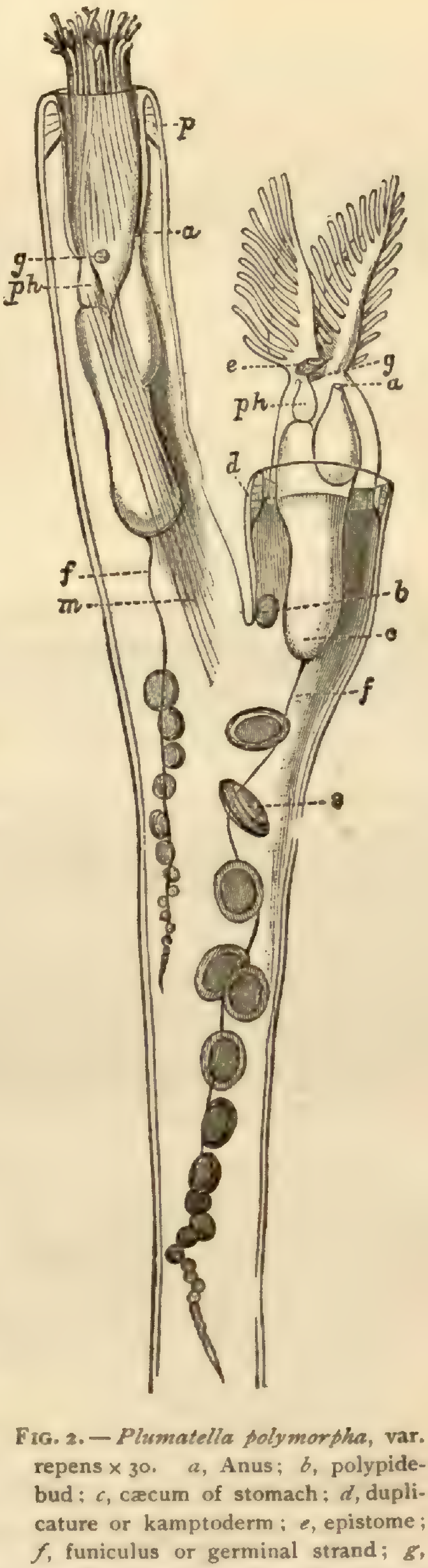

Fig. 2. — *Plumatella polymorpha*, var. repens × 30. *a*, Anus; *b*, polypide-bud; *c*, cæcum of stomach; *d*, duplicature or kamptoderm; *e*, epistome; *f*, funiculus or germinal strand; *g*, ganglion; *m*, retractor muscle; *p*, parieto-vaginal muscles; *ph*, pharynx; *s*, statoblasts developing on funiculus. From Cambridge Natural History.

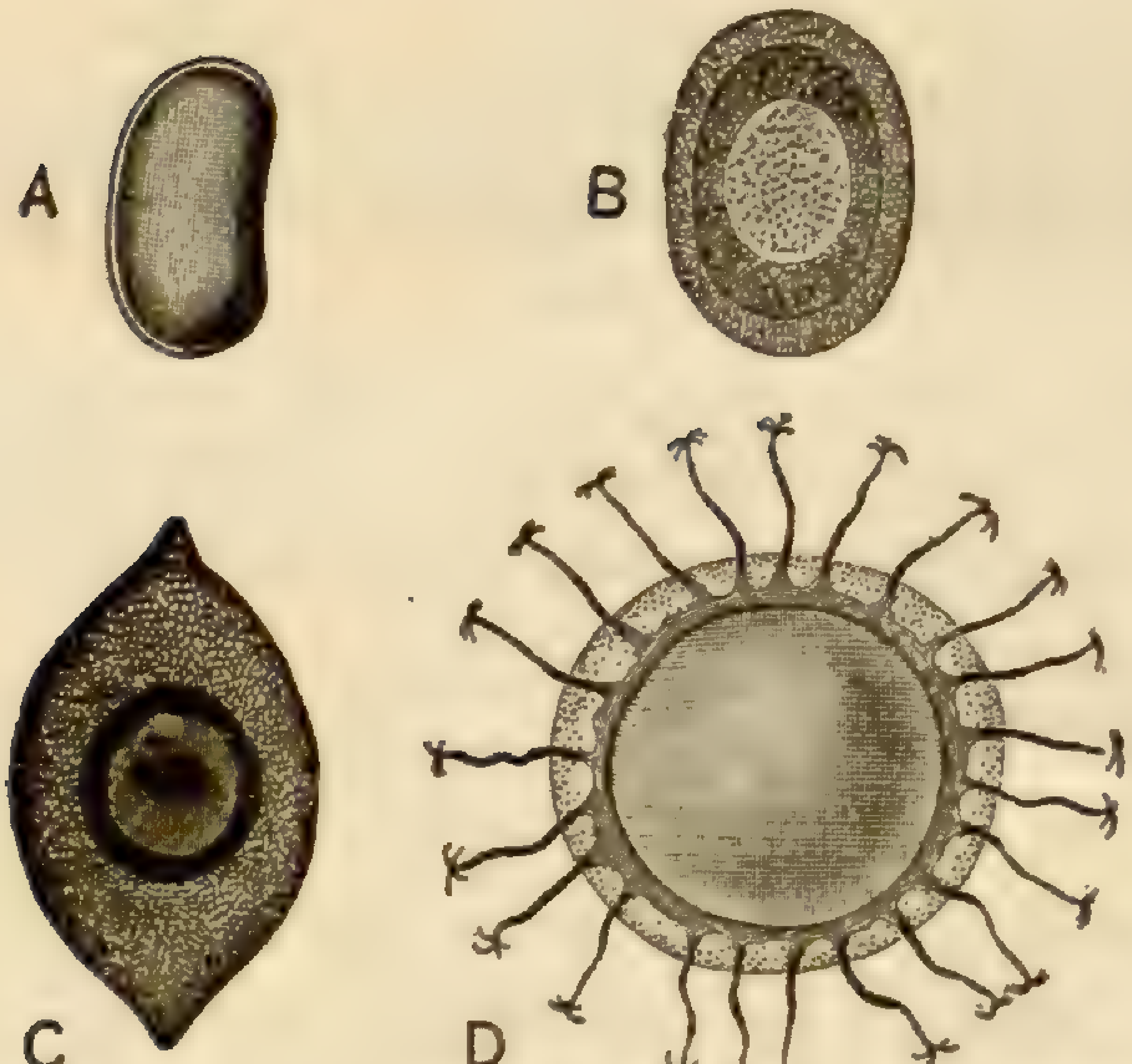

Fig. 3. — Statoblasts of Phylactolæmata. A, *Fredericella sultana* × 38; B, *Plumatella polymorpha* × 38; C, *Lophopus cristallinus* × 28; D, *Cristatella mucedo* × 28. From Cambridge Natural History.

Key for the Determination of American Fresh-Water Bryozoa.[1]

a_1. Anus opening inside the tentacular corona [Endoprocta]. *Urnatella gracilis.*

a_2. Anus opening outside the tentacular corona, which is capable of being retracted [Ectoprocta].

- b_1. Zoœcia sharply separated from each other; no epistome [Gymnolæmata].
  - c_1. Zoœcia cylindrical, arising from stolons; aperture terminal. *Pottsiella erecta.*
  - c_2. Zoœcia club-shaped, no stolons; aperture lateral. *Paludicella ehrenbergii.*
- b_2. Zoœcia confluent, epistome present [Phylactolæmata].
  - c_1. Statoblasts without thorns, rounded at ends.
    - d_1. 20–22 tentacles arranged nearly in a circle; statoblasts without peripheral float. *Fredericella sultana.*
    - d_2. 38–60 tentacles arranged in form of horseshoe. Free elliptical statoblasts with a peripheral float [Plumatella].
      - e_1. Free statoblasts elongated; proportions, 1 : 1.53 to 1 : 2.8. *Plumatella princeps.*
      - e_2. Free statoblasts nearly circular, 1 : 1 to 1 : 1.5.
        - f_1. Free ends of zoœcia fairly distinct from basal tubes, cylindrical or irregularly constricted. *Plumatella polymorpha.*
        - f_2. Free ends of zoœcia mere conical elevations of basal tubes, covered with white spots. *Plumatella punctata.*
  - c_2. Statoblasts acutely pointed at both ends, without thorns. *Lophopus cristallinus.*
  - c_3. Statoblasts with anchor-shaped thorns.
    - d_1. Zoöids form rosettes on a gelatinous base, often attaining great size. *Pectinatella magnifica.*
    - d_2. Stock caterpillar-like, with broad sole. *Cristatella magnifica.*

Literature on Fresh-Water Bryozoa.—Allman, G. J., A Monograph of the Fresh-Water Bryozoa, London (*Roy. Soc.*), 1856.—Hyatt, A., Observations on Polyzoa, Suborder Phylactolæmata, *Proc. Essex Institute*, IV and V, 1866–1868.—Leidy, J., Urnatella Gracilis, *Journ. Acad. Nat. Sci. Philad.*, 1883.—Potts, E., On Paludicella Erecta, *Proc. Acad. Nat. Sci. Philad.*,

[1] The *American Naturalist* will undertake to determine and return any specimens that cannot be placed in the keys, and solicits correction and criticism for future revision.

1884.—Kraepelin, K., Die Deutschen Süsswasserbryozoen, Teil I, *Abh. Naturw. Verein*, Hamburg, X, 1887; Teil II, *ibid.*, XII, 1893.—Braem, F., Untersuchungen ueber die Bryozoen des süssen Wassers, *Bibl. Zool.*, II, 1890.—Davenport, C. B., Cristatella: the Origin and Development of the Individual in the Colony, *Bull. Mus. Comp. Zool.*, Harvard, XX, 1890, and on Urnatella Gracilis, *Bull. Mus. Comp. Zool.*, Harvard, XXIV, 1893.

NOTES ON THE HABITS OF BASCANION CONSTRICTOR.

W. E. PRAEGER.

Early in August, 1898, when staying on a farm in Hancock County, Ill., I captured a fine black snake (*Bascanion constrictor*), a typical specimen about five feet long. One hot afternoon we were disturbed by the alarming report that a snake was in the henhouse. I investigated and found the snake among the boxes and straw, but for a moment the species puzzled me. Only its head and a small part of its body could be seen lying on the eggs of a hen's nest. Immediately behind the head the neck was greatly distended, colored pink and yellow, with fine longitudinal lines of black spots. Closer inspection showed that the black lines were rows of scales on the greatly stretched skin of the neck, and its guilt as a nest robber was manifest. The snake lay perfectly quiet, and as seizing it by the neck in the orthodox manner was impossible without breaking the egg it had swallowed, I took hold of it by the body. As though in preparation for fight or flight the egg was at once broken, apparently by some muscular contraction, the contents running out of the mouth, and the neck quickly assuming its normal proportions. During the five weeks that it was in captivity I frequently offered eggs to it, but no other food, for I was interested to see how such a small pair of jaws could encompass an entire hen's egg; but it refused to gratify my curiosity, and ate nothing while I had it.

The snake was kept in a small box, but was frequently released on the porch or lawn, and allowed its freedom for a while. Its one idea seemed to be to escape, though it went about it deliberately, and did not show any signs of fright. When touched, it struck quickly with open mouth at the object, but the wounds inflicted in this way on my hand were very

trifling. Black snakes have been described as expert climbers, which my captive soon showed me to be true. On the lawn stood a fine black oak (*Quercus tinctoria*), the trunk eight feet in circumference, perfectly straight, and for fifteen feet without a branch. Up this trunk our snake would go, apparently preferring it to the smooth lawn as a way of escape. The course pursued was always right up one side of the tree, and no attempt was made to encircle it. The general direction was perpendicular to the ground, the irregular curves of the body being comparatively slight. Once clear of the ground, progress was very slow; the head and neck were sometimes moved deliberately from side to side, presumably in search of a good hold. It never moved hurriedly, and there was probably always some part of its body not in motion, though this was not always apparent. It took close inspection to see that, here and there, the edge of a ventral plate was caught on some slight projection of the bark, and even then the appearance of the snake against the perpendicular trunk of the tree seemed like a defiance of the law of gravity. The muscles were thrown into unusual prominence, and constantly changed in appearance throughout its length, their contractions showing the effort needed to make the ascent.

Once while I was absent the snake escaped from its box and climbed up the smooth stone wall of the house, to a height of about thirteen feet, aided only by a few small nails and a wooden moulding above the arch of a door.

In more favorable situations our captive showed that climbing by black snakes was not necessarily slow and laborious. The ease and silence with which it could glide through the loose tangle of the vines (*Ampelopsis quinquefolia*) that covered the porch railing was remarkable; and to disentangle it from this, or from among the branches of some bushes that grew near, was not easy. A single crook of its muscular body across a branch made a firm hold, but it never twisted itself entirely around a branch. It would make for any hole that offered; the hollow stump of a small tree was a favorite retreat, and when even but a short way into this hole it was no easy matter to get it out. The body was bent so that it was pressed

against the rough sides of the cavity, and it was only by main strength on my part, and always with injury to its scales and plates, that it could be pulled out.

Placed on a porch floor, the body and tail were lashed in strong curves from side to side, but forward progress was very slow. On the tennis lawn the curves of the body were less pronounced, and the forward movement more rapid. However, it was only when it reached long grass or rough ground that the snake straightened out and went forward with that mysterious gliding motion peculiar to its kind. As an onlooker once described it, "when he strikes rough ground he quits wiggling and just scoots."

A NEW NAME FOR THE GREAT CRESTED ANOLIS OF JAMAICA.

LEONHARD STEJNEGER.

HERPETOLOGICAL writers have shown a curious unanimity in misnaming the large crested Anolis of Jamaica *Anolis edwardsii*, Merrem.

Merrem, in 1820 (*Syst. Amph.*, p. 45), gave the name *Anolis edwardsii* to a lizard figured by Edwards as "the Blew Lizard from the Island of Nevis," and never mentioned Jamaica as its habitat. Merrem knew nothing of the species beyond Edwards's description and figure, upon which, consequently, the specific name rests.

Edwards, in his *Gleanings of Natural History*, Vol. I, p. 74,[1] describes, and on Pl. 245 figures "immediately from nature, and of the size of life," an Anolis which "was brought from the island of Nevis, in the West Indies, by a young gentleman who came to London for education," and who presented it to him "preserved in spirits." After alluding to the digital expansion of this lizard as its most particular feature, he says: "It hath a small ridge down its back, which extends to the tail, where it becomes jagged or toothed."[2] We do not expect to find in a drawing of 1753 all the minute details which would enable us to identify with certainty a lizard of this extremely difficult genus, but Edwards's figure shows very well the above-described features, namely, a nearly smooth dorsal fold continued as a toothed crest on the tail. This alone is sufficient to show that he did not have before him the Jamaican large crested Anolis, the very character of which is the "dorso-

1 This volume, in the edition of 1805 at least, is erroneously indicated on the title-page as "Volume V."

2 "Il y a une petite élévation sur le dos, en forme de sillon, qui règne tout du long jusqu'à la queue, où elle devient dentelée" (French rendition in the parallel column).

nuchal crest of triangular scales,'' or, in other words, a crest on the back precisely like that of the tail, and not at all like the dermal fold so characteristic of another group of Anoles. Add to this that Edwards's figure is life size, and yet only about one-half that of the Jamaican species, and that the latter, or any species of the same group, does not occur on Nevis, nor in fact on any of the Caribbean Islands, while another species of the group with the dorsal fold is known to live on Nevis, and the conclusion is inevitable that the great crested Anolis of Jamaica has been wrongly named *A. edwardsii.*

As it has received no other name, a new one has to be provided, and I propose to call it *Anolis garmani*, in recognition of Mr. S. Garman's important studies of West Indian Anoles. I may add that the species is briefly mentioned by Sloane (*Nat. Hist. Jamaica*, Part II, 1725, p. 333) as *Lacertus major e viridi cinereus, dorso crista breviori donato*, and figured on Pl. 273, Fig. 2. This has usually been referred to *Anolis equestris*, from Cuba, but is plainly the Jamaican species. It is certain that true *A. equestris* does not occur in Jamaica.

EDITORIAL COMMENT.

"Scientia." — We are glad to note the establishment of a new French scientific series — "*Scientia*, exposé et développement des questions scientifiques à l'ordre du jour." This is to appear in two parts: one, a physico-mathematical one; the other, biological, which chiefly concerns us. The aim of the series is to exhibit in a clear and philosophical way the results of recent discoveries and the general directing ideas. It is proposed to treat the subjects in a living way, giving reasons for conclusions and the conflict of views. The cost of each volume, neatly bound in cardboard, is two francs, or six for ten francs.

There is room for such a series, and the first two volumes which we have received, one by Bard on Cell Specialization, and one by le Dantec on Sexuality, lead us to expect good things from the undertaking.

Western Morphologists. — We have recently received a letter from Professor Henry B. Ward, of Nebraska University, suggesting the formation of a western section of the American Morphological Society. This is a matter which the *Naturalist* would like to see fully discussed. We have already referred to the fact that the very extent of our country works against a proper unity of American scientific men, and that a society which meets in successive years at places five or seven hundred miles from one another loses that continuity of endeavor essential to the most effective work. We are consequently at present inclined to regard the suggestion of Professor Ward as good, and to believe that the formation of a section of the "Morphologists" in the Mississippi Valley, which might meet once in three or five years with the Society of Naturalists and the eastern section of the "Morphologists" at some border-line city, would serve to develop the science in America.

REVIEWS OF RECENT LITERATURE.

GENERAL BIOLOGY.

The Specialized Nature of Cells.[1] — The author brings facts, largely from the medical literature, to support his modification of Virchow's famous dictum, so that it reads: *Omnis cellula e cellula ejusdem naturæ.* In the first chapter he discusses the relative claims of the theories of the indifferent nature and the specialized nature of cells in the body. Next he considers the hereditary fixity of cell-types in adult organisms, and attempts to show that all conclusions that in pathology or regeneration the organs of new growths arise from other than like cells in the body, rest upon erroneous interpretation. Unfortunately many of the best cases supporting the view he combats (such as Wolff's case of the regeneration of the Amphibian lens) are not considered by the author. The third chapter deals with the origin of specialization of cells during development, which he believes comes in with the germ-layers. Finally cell specialization is considered from the standpoint of life and heredity.

Although one-sided and speculative, the book has a value as giving the point of view of a medical man.

Sex.[2] — This small book, by the well-known French writer on topics of a general biological nature, gives a résumé of the general facts of sexual dimorphism, parthenogenesis, the dependence of the secondary sexual characters on the primary, the epoch and conditions of sex-determination, and the theory of sex. In the chapter dealing with secondary sexual characters the author considers sexual selection, the results of castration, and the phenomena of hermaphroditism. Other chapters are treated with equal fullness.

The author proposes a hypothesis of sex which he admits is very uncertain. It is that all the elementary living substances have two inverse and complementary types; just as many inorganic molecules appear in two forms. One of these types is the male; the other the female type.

[1] Bard, L. La Spécificité Cellulaire, ses consequences en biologie générale, *Scientia, Sér. Biologie, No. 1.* Paris, Carré & Naud, 1899. 98 pp.

[2] Le Dantec, F. La Sexualité, *Scientia, Sér. biologique, No. 2.* Paris, Carré & Naud. 99 pp.

The work is clearly written, and the author frequently reduces his statements to a mathematical form. The book will be useful to teachers.

The Removal from the Water of Nitrogenous Matter Excreted by Marine Animals has been investigated by Mr. H. M. Vermon, at the Naples Station, by chemical, physiological, and bacteriological methods. Green seaweeds in aquaria remove the free, but increase the albuminoid, ammonia, and favorably affect the growth of sea-urchin larvæ. Neither form of ammonia is decreased by the red seaweeds, and larvæ do not thrive in the water except in direct contact with a small quantity of the weed. Sand with no vegetable matter had no purifying power, but when clogged with diatoms and algæ, it removed as high as 96 per cent of the free, and 51 per cent of the albuminoid, ammonia. Bacteria are important agents in the purifying process, especially in the removal of the free ammonia. The bacterial slime lining the aquarium pipes materially purifies the water. Purification is greatest at the maximum rate of filtration, though the number of bacteria is increased considerably by the use of the clogged sand-filter. The removal of the ammonia favors the development of the larvæ.

C. A. K.

ANTHROPOLOGY.

Physical Qualities of the Children of Prague.[1] — Dr. Matiegka, one of the foremost Czechish anthropologists, has contributed largely to the knowledge of Bohemian craniology and other subjects. The present work is a contribution to the study of school children of the capital of Bohemia. It has been preceded by studies "On the Influences which Act on the Weight and Length of the New-Born Children in Bohemia,"[2] "On the Period of Puberty among Bohemian Girls,"[3] etc., by the same author. The work at hand is full of interesting details and comparisons, and well deserves a translation into the English language.

The children included in the examinations range from 5½ to 14

[1] Matiegka, Jindrich. The Growth, Evolution, Physical Qualities, and the Hygienic Conditions of the Children of Prague, *Trans. Bohem. Acad. of Sci. and Art*, Ann. vi, Cl. ii, No. 17, pp. 1–78, with tables. Prague, 1898.

[2] *Journ. of the Bohem. Phys.* (1894), p. 245.

[3] *Bull. of the Bohem. Assoc. of Sci.* (1897), XV.

years of age. There were ascertained with each child the date of birth, state of nutrition and of musculature, height, weight, circumference of the head, circumference of the thorax at inspiration and at expiration, color of eyes and hair, condition of teeth, principal qualities of sight and hearing, morals, abilities, and existence of diseases past and present. The actual examinations were conducted principally by the teachers of the children, the whole work being authorized and supported by the municipality.

Among the main results of the investigations the following are important:

Births. — The maximum rate of conceptions occurs in May and a part of June.[1] In the months in which the greatest numbers of children are born there is also observed the greatest average weight of children. The vitality of the children born in these months does not suffer.

State of Nutrition. — Only about one-half (49.8 per cent) of all the children examined were found to be "well nourished," which shows us best what conditions exist in the large European cities, Prague in no way being an exception. Seven and six-tenths per cent of the children examined were nourished "badly." After the 11th year the percentage of well-nourished children increases noticeably. The districts in which the poor classes of people live show a great predominance of only medium or badly nourished individuals.

The condition of the musculature corresponds closely to the general state of nutrition of the children.

Height. — The difference between the maximum and minimum height of children of the same age was found to be very considerable. The difference reached the maximum of 45.75 cm. Under these circumstances a boy of 10 years of age was found to reach only the average height of boys of 6 years of age, while another boy of 10 years attained the average height of a boy of 14. The average height of the boys compares thus with the height of Boston boys[2]:

Years	6	7	8	9	10	11	12	13	14
Prague boys	109.9 cm.	115.5	120.5	125.3	129.4	133.5	138.9	144.3	150.9
Boston boys	111.1 "	116.2	121.3	126.2	131.3	135.4	140.0	145.3	152.1

[1] In New York the greatest number of births occur, with considerable regularity, in August, which places the maximum number of conceptions in November. See my *Rep. on Anthropol. Work in the State Institutions for Feeble-Minded*, Syracuse (1898), p. 8.

[2] Bowditch, H. P. *Ann. Rep. of the State Board of Health of Massachusetts* (1877), p. 275.

The rate of growth of American and Bohemian boys does not differ materially, but the Bohemian boys remain throughout life between 1 and 2 cm. shorter. It is difficult to say how much of this smaller height is due to racial characters and how much to inferior nutrition. The Bohemian boy is also smaller than the English and Swedish boy, but surpasses in height the Belgian, Polish, Italian, and most German male children. The children of poor classes show much smaller average height than the children of well-to-do people. This has been equally observed on American children (Bowditch, Boas).

Weight. — The average increase in weight was not found to correspond exactly, or at all ages of the children, with the height. The weight of the boys was as follows:

Years	6	7	8	9	10	11	12	13	14
Prague	18.6 kg.	21.2	23.4	25.1	27.2	30.8	33.4	36.8	40.7
Boston (Bowditch)	20.5 "	22.5	24.5	26.9	29.6	31.8	34.9	38.5	42.9

The American boys are at all ages, but especially at 10 and from 12 years upward, the heavier. Up to the 7th year the weight of the Bohemian girls and boys was found almost alike; from 7 to 12 years the girls remain behind the boys in weight; from the 12th year, however, they begin to surpass the boys. This fact has been observed by other investigators. It signifies the approach of puberty, which in girls begins by augmented deposition of fat.

The Circumference of the Head measures show the following averages:

Years	5½	6	7	8	9	10	11	12	13	14
cm.	50.72	50.92	51.18	51.43	51.75	51.9	52.12	52.34	52.8	53.05

The average annual increase = 0.28 cm. The measures are slightly (0.5 to 1.0) smaller than those which I obtain in American-born children of same ages, which is in relation with the somewhat greater height and weight of these children.

Circumference of the Thorax. — This is a very uncertain measure. The average circumference of the thorax of the 6-year-old Prague male children was 58.7 cm.; the annual increase amounted, on the average, to 1.6 cm. The increase was least between 6 and 7, and again between 11 and 12 years; but, as it was the greatest between the years 7 and 8 and 12 and 13, the probability is that the average differences in age between the two series were greater than 12 months. The thoracic circumference of the 14-year-old boys reached 72.0 cm.

Color of Hair and Eyes. — These characters allow us to distinguish two types in Bohemia ; namely, the blonde, which prevails in the north and in the more mixed districts, and the dark, which prevails in the south and throughout the more purely Bohemian districts. In Prague and other large cities considerable mixture of these two types occurs. According to all indications, the dark type is gradually gaining on the blonde. Among children the hair, which is often light in early age, as years advance, in many cases rapidly becomes darker. The color of the eyes is more stable. Red hair is exceptional (1.9 per cent). The dark type of children shows certain physical advantages over the light type, but the medium or mixed type surpasses both and has apparently the best chances of existence.

Influence of the Occupation or Social Position of Parents on the Physical Condition of the Children. — This subject is naturally very complex. The results of the investigation show that the physical development of the children corresponds (*a*) to that of the parents, and (*b*) to the kind and abundance of food and the degree of other hygienic conditions. The children of butchers and dealers in smoked meat are among the best developed ; on the other hand, the children of shoemakers and those of railroad employees are among those that show most defects of development. The results indicate that the physical state of a child is partly due to heredity, partly to acquisition. Children of immigrants (from the country) are in a somewhat better physical condition than city-born children.

Morals and Abilities. — The best-developed children show the largest percentage of able children, and *vice versa*. This is in accord with the results obtained by Gracianov (Russia), Sack (Russia), Porter (St. Louis). The extremes of the blonde and the dark type show smaller proportions of able children than the middle type. The more able children show larger average circumferences of the skull than the less able. The most prevalent form of the head among the able Bohemian children is a moderate brachycephaly.

As to the relation of the morals and physical condition of the children, nothing definite can be said. The size of the head of moral children seems to be, on the average, slightly greater than that of immoral individuals.

Diseases of Childhood. — The author finds that children with light hair and light eyes, hence the blonde type, are more frequently attacked by various infectious diseases of childhood. Boys with dark eyes are attacked by measles and variola with a little more frequency than boys with blue eyes. The most favorable conditions are

again noticed among children of the mixed type. The city-born children show a slightly greater tendency to infectious diseases, except to scarlatina, than those born in the country.

The city-born children examined show 8.2 per cent of short-sighted individuals, those born in the country only 7.6 per cent. Defects of hearing were noticed in 5.4 per cent of the 7607 boys examined. These data cannot be considered in any way as very exceptional. Myopia is more frequent among the dark, defects of hearing among blonde, children.

Such are, briefly, the results of the study of Dr. Matiegka. The creditable work arouses the reflection, Why do not all our large American cities follow the example of Boston, Worcester, Toronto, St. Louis, where highly successful work of similar nature has been done? Our cities are certainly more able financially to support work of this nature than is Prague, or, in fact, any European city; and the investigations are at least more desirable and promising than in any European capital. The most interesting and instructive conditions of choice, mixture, survival, and, possibly, evolution, are passing under our eyes unrecorded. This is a country which presents almost all the climates, an infinity of social conditions, and a large number of racial relations, which all more or less affect the development of the American of the future. Yet most of these opportunities are neglected. This is only partly, if at all, due to a lack of the proper men to do the work. The main obstructions which the American anthropologist has to contend with in this particular line are a disinterested, or even unfavorable public sentiment and, what will no doubt appear incomprehensible to our European colleagues, a lack of funds.

Ales Hrdlicka.

Anthropological Notes. — In the April number of the *Geographical Journal* it is stated that letters from Mr. Low, dated December 30, have been received, telling of his arrival at Great Whale River, on the east coast of Hudson Bay. He had surveyed about five hundred miles of coast, half of which was entirely new. Mr. Low carried a pair of skis with him, and states that the Eskimos of Great Whale River are devoting themselves to making and learning to use skis.

In the same journal Mr. Edward Heawood gives a summary of the contents of a dozen recent books on Africa.

Dr. William Sorenson, of Copenhagen, we are told in a paragraph in *Natural Science* for April, has shown that Worsaae was the first to

discover the true character of kitchen-middens. "Fifty years ago it was an audacity to believe in men so very ancient as these oyster-eaters. Now we only think of their audacity in eating so many oysters."

The *Smithsonian Report* for 1897 contains an account of the archæological field work of Dr. Fewkes for that year. The primary aim of his explorations was to trace the migrations of the Hopi from the South, and to determine the limits of the Hopi and Zuni zones of ruins in Arizona and New Mexico, respectively. The greater part of the summer was spent in the Pueblo Viejo region; from the identity in color, texture, and decoration of the pottery in upper and lower Gila ruins, and the fact that in both regions the people cremated their dead, Dr. Fewkes concludes that the former inhabitants were of a similar state of culture, if not of the same stock. The distribution of the varieties of pottery is shown by maps, and its form and decoration by numerous plates.

During the excavations made at Brassempouy in 1897, by MM. E. Piette and J. de La Porterie, a number of interesting examples of prehistoric art were discovered. Especially noteworthy among these were the engravings representing the horse and other animals. To the reprint from the original paper in *l'Anthropologie*, Vol. IX, pp. 531–555, is appended a list of the numerous scientific papers by M. Piette, which extend over a period of nearly half a century.

In an entertaining paper upon the Indian Congress at Omaha, published in the *American Anthropologist* for January, 1899, Mr. James Mooney has condensed much valuable information regarding the present status of the Indians. About twenty tribes were represented at the Congress, mostly of the plains type; these are briefly described, and a table containing a few words from their languages is added.

A number of articles of anthropological interest are to be found in Vol. XII, Part III, of the *Proceedings of the American Antiquarian Society*. Edward E. Hale describes the manuscript dictionaries of the Massachusetts Indians which were bequeathed to the society by Dr. J. Hammond Trumbull. These have been placed in the hands of Albert S. Gatschet for publication by the Bureau of Ethnology. G. Stanley Hall gives an account of "Initiations into Adolescence," particularly church initiations.

G. Papillault has published a valuable paper upon the "Ontogeny and Phylogeny of the Human Cranium" in Vol. IX, No. 4, of the *Revue de l'École d'Anthropologie de Paris*.

The results of an extended and valuable anthropometrical investigation have been recently published by Dr. Ales Hrdlicka, who measured and examined the thousand white and colored children in the New York Juvenile Asylum and the hundred colored children of the New York Colored Orphan Asylum. The object of the investigation was "to learn as much as possible about the physical state of the children who are being admitted and kept in juvenile asylums. In the second place, this study is a part of the general anthropometrical work of the author, and thus expected to result in an addition to our knowledge of the normal child and of several classes of children who are, morally or otherwise, abnormal." The plan of arrangement of the records obtained will show the scope of the work. 1. General data on the total of subjects. 2. Detailed study; children in this group are separated according to their color, sexes, and ages. 3. Physical differences between white and colored children of both sexes and different ages. 4. Children of different nationalities. 5. Children without any physical defects, with their family and individual histories. 6. Children with five or more physical abnormalities. 7. Vicious and criminal children. 8. Children whose parents were intemperate, prostitute, or criminal. 9. Children both of whose parents are dead. 10. Children one or both of whose parents died of consumption.

F. R.

PSYCHOLOGY.

"The Dawn of Reason." — Dr. Weir has written an exceedingly readable book in his *Dawn of Reason*,[1] and one important for the large results it presents of personal study of the simpler forms of life, and of original research upon the nature of their sensory processes. As its chief title indicates, the aim of the work is to trace back mental traits to their origins, and to point out their earliest manifestations in the scale of animal life.

In ten chapters the author treats the Senses in the Lower Animals, to which he adds two auxiliaries, Color-change and the Homing Sense; Teleological Reactions, including Simulation of Death; Memory, Emotion, Æstheticism, and Parental Affection.

It is difficult to estimate the value of the author's results, since

[1] Weir, James Jr., M.D. *The Dawn of Reason;* or, Mental Traits in the Lower Animals. New York, Macmillan. 8vo, pp. 234.

the conditions under which they were obtained are so meagerly given. For the appraisal of such work it is of the first importance that the reader should know that the conditions of experimentation were beyond cavil, for in any scientific investigation the whole significance of the evidence may turn upon the observance of apparently slight precautions, and scarcely a hint is here given of the methods and control of conditions by the investigator. The book is throughout — if we except the detailed and patient analysis of nervous structure and sensory processes in the lower orders of life — rather observational than experimental, and the author is inclined to rely upon an interpretation of significant incidents instead of extended and systematic tests.

In regard to several of the author's conclusions criticism may be entered. Dr. Weir has made many interesting observations concerning the location and acuteness of the sensory organs in the lower animals, but when among these senses he proposes to include tinctumutation and letisimulation, I must demur. Color-change is a reaction upon a particular environment, not a perception of the nature of that environment, and is no more a sensory process than is the flight of an insect to escape the sudden leap of a toad. Sensory is contrasted with motor as perception with reaction. The color-change may depend upon a sensory stimulus as does the action of the insect escaping the toad, and the function may cease upon the extirpation of certain nerve centers, — either sensory, by which it becomes insensible to the change in the environment, or motor, by which it becomes unable to adapt itself to that change, — but it is not, therefore, more of a sensory process than is the reactive adjustment of the insect. The writer must go much farther than this to prove his point, for the establishment of a connection between motor function and nerve-center activity does not evince even the existence of an accompanying sensory process. The whole function might be a reflex form of activity without accompanying consciousness.

Dr. Weir objects to calling this function an instinctive one, but unless he should maintain that it is an adjustment empirically acquired by the individual, in thus establishing its dependence upon a sensory process he has but proved its analogy to all instincts, which are essentially perception-reactions, and differ from acquired habits only in the nature of their origin. The impulse may or may not be accompanied by awareness of its significance, but this comment in no way affects its character as an instinctive impulse.

In his treatment of letisimulation the author reduces it to the

type of the color-changing function, a perception-reaction of teleological fitness under the given environmental conditions. He conceives it throughout as a true simulation, a "device," "pretense," or feigning; but this is by no means an indisputable conclusion. It overlooks the theory that the simulation of death is a true syncope, the temporary paralysis of the nervous system being induced by sudden shock — a theory which views the process as an advantageous adaptation to the environment, but not a designed adjustment to it. This conception is apparently overlooked in the book, yet in view of the conflict of evidence, no investigator is justified in putting it aside unconsidered. Preyer regards the whole phenomenon of letisimulation in insects as due to cataplexy, and Romanes, while commenting favorably upon this opinion, cites other authorities who interpret after the same fashion the feigning of death in the higher vertebrates as well.

ROBERT MACDOUGALL.

The Methods of Comparative Psychology.[1] — In his *Dawn of Reason*, Dr. Weir's sympathetic interpretation carries him, I am inclined to think, too far in his ascription to lower orders of life of processes and methods analogous to those of human mental activity. It is possible to read too little of psychical accompaniment into the animal's actions, as in the extreme type of Cartesian automatism, and it is possible also to read too much. To illustrate with an incident at hand: A Boston lady had a pet house-dog whose favorite snoozing-place was a certain cushioned chair. If his mistress needed the chair and found him occupying it, instead of roughly ejecting him, her method was to adopt the ruse of calling him to the window by pointing to something in the street and telling him to watch, whereupon she would take possession of the coveted seat. One day, while seated in the chair herself, the dog came into the room, and after nosing about for a moment, ran to the window, gazed up and down the street and began barking excitedly. His mistress soon arose and came over to seek the cause of the dog's alarm. Unable to discover anything, she turned away toward her easy-chair again, but only to behold the little animal snugly curled upon it in oblivion and content. Reasoning from analogy between the actions of the dog and those of his mistress, one would say that he had deliberately made use of artifice to obtain possession of the seat. The only facts contributed by the incident itself, however, are the barking

[1] Mills, Wesley. The Nature of Animal Intelligence and the Methods of Investigating It, *Psychological Review*, vol. vi, No. 3, May, 1899.

at the window and the jumping upon the chair; all the rest is a comment by the observer, and the hypothesis of artifice must maintain itself by further proofs than the incident in question affords, against the supposition that the acts were independent and both of them naïve. The parsimonious view is adopted by Dr. Edward Thorndike in a monograph,[1] which Professor Mills discusses in the present article. Aside from the more special problems of Memory and Imitation in the lower animals, concerning which he is at issue with the writer of that monograph, Professor Mills takes up two questions of the first importance in comparative psychology. The first is that of the methods and conditions of experimenting; the second that of the interpretation of data.

In systematic investigations of the life of the lower animals it is often unavoidable that the subject of experimentation should be surrounded by artificial conditions, — range must be limited, dietary changed, and daily routine of acts readjusted, — but every such innovation is a fresh obstacle in the way of the sincere observer, and to introduce them wholesale, or to overlook their disturbing influence is simply to destroy the whole value of one's results. In many cases the familiarity or strangeness of the environment is the controlling element of the experience, and to fail of taking it into account is to miss the whole significance of the action. Dr. Thorndike's results come very near to being valueless if, as Professor Mills says, "This investigator has practically ignored this in his tests, for he placed cats in boxes only 20 x 15 x 12 inches, and then expected them to act naturally. As well enclose a living man in a coffin, lower him against his will into the earth, and attempt to deduce normal psychology from his conduct."

The value of Dr. Weir's observations lies very greatly in just this fact, that his book is the result of a score of years afield, where he studied the animals as he found them, living the free life of their natural habitat, and not under the inhibitions and disturbances of an artificial laboratory environment.

The second point of Professor Mills's discussion is of scarcely less importance, namely, the interpretation of the data afforded by the actions of the animals under observation. Comparative psychology labors inescapably under the disadvantage of an indirect method of observation. Here, unlike all human psychology, no experience can be reported upon by its subject. The investigator must depend

[1] Animal Intelligence. Monograph Supplement to the *Psychological Review*, vol. ii, No. 4, whole number 8.

wholly upon those secondary results of mental activity which are expressed in the form of physical changes. From these he must analogically reconstruct the set of psychical changes which it is the intention of his psychology to describe. His way is thus beset with peculiar difficulties, and every precaution must be taken to guard against false interpretation of the data. Reaction from the flagrant error of freely reading human motives and play of ideas into the actions of the lower animals must not lead us into the equally false position of assuming that the simplest explanation of such conduct must necessarily be the true one. When my dog follows me to the corner of the street and, on seeing me turn in the direction of the market square where he has been roughly used, instead of toward the college yard whither he has always followed me with delight, drops suddenly upon his haunches, watches my steps a moment, and then turns homeward, his action is to be explained in accordance with the more complex hypothesis, not with the simpler. His interest has not died out, nor has a new object attracted him. The desire to accompany me is still a living motive, but its effect is transformed into an act of the opposite nature through the more powerful motive of fear. This is but an illustration of a condition of affairs which is constantly met with, in which the advocates of the simplest explanation are wholly out of court. Inhibition plays a tremendous part as a determinant of action in the lower animals, and the deficiency of our accounts of their mental life is doubtless in part due, as Professor Mills says, to the fact that "insufficient attention has been given to distinguishing between normal, sub-normal, and super-normal comparative psychology," and especially, I may add, to the lack of an intimate study of the relation of the animal to its environment with regard to the facts of inhibition and disturbance of normal motivation.

ROBERT MACDOUGALL.

ZOÖLOGY.

Some Japanese Oligochæta. — In the course of the year 1898, three papers on "Japanese Oligochæta" appeared in the *Annotationes Zoölogicæ Japonenses*, which materially extend our knowledge of this division of Japanese fauna. In the first of these — "On a New Species of Littoral Oligochæta" (*Pontodrilus matsushimensis*)[1] — Akira Iizuka describes a new species of Pontodrilus.

[1] *Annotationes Zoölogicæ Japonenses*, vol. ii, Pt. i, pp. 21–26.

This species lives in sand along the shore of Matsushima Bay, and so has the same sort of habitat as have several other species of the same genus, which are found along the seashores of other countries.

P. matsushimensis agrees with the other Pontodrilus species known to Iizuka in most characters of generic value, as the genus is defined by Beddard in his monograph; the chief difference being in the position at which the sperm duct actually opens into the spermiducal gland. According to Beddard, the position of this opening is at the "junction of glandular and muscular parts" of the spermiducal gland, while in the Japanese species the sperm duct enters the wall of the glandular part near its junction with the muscular portion, and then traverses the wall to the other end of the glandular portion before actually communicating with its lumen. As this relation of the sperm duct to the spermiducal gland is apparent only from a study of serial sections, and as Iizuka assumed that no other species of Pontodrilus had been studied in this way, he concluded it probable that similar relations would be found to exist in the other species. The writer seems not to have been aware of the extended and careful work of Eisen[1] on *Pontodrilus michælseni*, published in 1895. Eisen's account of this species is accompanied by numerous figures made from cross-sections, and shows that the superficial entrance of the sperm duct into the spermiducal gland has nearly the same position as in the case of *P. matsushimensis*, but furnishes no evidence that the internal communication is the same. On the contrary, it would indicate that the communication of the lumen of the sperm duct with that of the gland is near the point of the superficial entrance of the duct into the gland. This condition of things in *P. michælseni*, while it may render doubtful the correctness of Iizuka's assumption that other species of Pontodrilus will be found to have the same relation of sperm duct and spermiducal gland as exists in *P. matsushimensis*, helps to bridge over the differences between that species and the others, and so lessens the necessity for establishing a new genus to receive it.

"New or Imperfectly Known Species of Earthworms" is the title of a paper in which the authors give us the first of a series of articles which they propose to contribute on the Oligochæta of Japan.[2]

In a third paper are described sixteen new species of Perichæta, and

[1] Pacific Coast Oligochæta, I, *Mem. Cal. Acad. Sci.*, vol. ii, No. 4.

[2] Goto, S., and Hatai, S. New or Imperfectly Known Species of Earthworms, No. 1, *Annotationes Zoöl. Japonenses*, vol. ii, Pt. iii, pp. 65–78.

mention is made of one other species which they doubtfully identify with *P. sieboldi* Horst, the first Perichæta species described from Japan, and one well known in European museums. Of over two hundred specimens belonging to this species, all without exception differed from the descriptions of *P. sieboldi* by European writers in one important character, *viz.*, the position of the spermathecæ. Since many of their specimens were collected from the same region from which the European specimens were known, or supposed to have been collected, it seems to be the inference of the authors that their species is identical with *P. sieboldi*, and that the European writers erred in their description of that species. Unfortunately their own description is so extremely meager that it is of little use to any one else who might attempt to determine the relations of their species to others already described.

Horst,[1] who first described *P. sieboldi*, has reëxamined the type of that species and confirmed the correctness of the earlier descriptions, and concludes that the two species are not identical.

The genus Perichæta already includes a hundred or more species, and the need is great for more detailed descriptions than those which our authors have seen fit to give us.

Horst calls attention to the peculiar fact that of the nine species of Perichæta previously described from Japan, none have come under the observation of Goto and Hatai.

In a third paper[2] is described a species living in the gutters and ditches of Tokyo, and belonging to the family Tubificidæ. These worms seemed to the author to be more nearly allied to *Vermiculus pilosus*, described from the southern coasts of England by Goodrich in 1892, than to any other form, and so are included in the same genus under the name *V. limosus.*

The description is reasonably complete and includes eight pages of text, accompanied by five diagrammatic figures.

Among the more noticeable peculiarities of the new species are the short, nearly straight sperm ducts which open into a common ventral spermiducal chamber on the eleventh somite, and the unpaired opening of the spermathecæ on the ventral side of somite X, both of which characters it has in common with the other member of the genus. Some peculiarities in which it differs from *V. pilosus* are the

1 Horst. On *Perichæta sieboldi*, *Notes from the Leyden Museum*, vol. xx, pp. 240–242.

2 Hatai, S. On *Vermiculus limosus*, a New Species of Aquatic Oligochæta, *Annotationes Zoöl. Japonenses*, vol. ii. Pt. iv, pp. 103–111.

single sperm sac, which is evaginated from the anterior septum of somite X into the ninth somite, from which it extends backward to the twelfth or thirteenth somite; and the ovisac, which extends backward from the twelfth somite instead of from the eleventh, as is more usually the case.

Hatai has experienced the difficulties so common in the preparation of purely technical papers of eliminating errors from the text, and we find the ovaries described as being located in somite X, while they are figured in somite XI. The latter position is undoubtedly the correct one; again, the sperm ducts are described as having the funnels in the ninth somite, while the main parts of the ducts are in the tenth somite, on the ventral side of which they open to the exterior. In the figure, which is more probably correct, they are represented as being situated one somite farther back. It is stated that there is a pair of ovisacs in the thirteenth somite, "formed by the backward bulging out, on the left dorsal side, of the anterior septum." As elsewhere in the text, reference is made in each case to "the ovisac," and as it seems improbable that both members of the pair should arise on the same side of the worm, it seems more reasonable to suppose that there is but one ovisac. F. Smith.

Strange Protoplasmic Budding in Epithelial Cells. — Every specialist is familiar with the occurrence of various vesicles and drop-like extrusions that may be found upon preserved epithelium, as if excreted. The formation of such "artefacts" has not been studied. Recently Martin Heidenhain, in the *Archiv. f. Mik. Anatomie*, Vol. LIV, pp. 59–67, has, however, described and figured peculiar finger-like protrusions from the cells of the epithelium of the uterus of a pregnant rabbit, and interpreted them as the first stages in the making of such "artefacts."

The material was hardened in corrosive sublimate, and the author conceives that this penetrating in molecular dilution acted as a stimulus to call forth a physiological, though pathological, response in the form of those protoplasmic protrusions, or pseudopodia.

How these protuberances later form the real artefacts, the vesicles, etc., that lie free from the cells, is not considered, since the chief thesis is that peculiar dark-staining bodies in each protuberance are centrosomes. The author advances much in favor of this view, and we seem to have here another case where motion of the protoplasm, in rising up to make protrusions of the surface matter, is localized about staining centers, or "centrosomes." E. A. A.

Catalogue of the British Columbia Provincial Museum.[1] — It includes mammals, birds, fishes, insects, trees, plants, fossils, ethnological specimens, etc. The distribution of the species of mammals, as well as the source of the museum specimen, is given. A full check list of the birds of the province bears a special check mark opposite those lacking in the collection, in order that the friends of the museum may know what is most acceptable. Very little is yet known of the birds of the northern and eastern parts of British Columbia. The eggs are listed, but the study-series of bird-skins, which are available to all students, is not published in the catalogue.

The ethnological collection is classified under several heads, as houses, dress, ceremony, craniology, etc. The introduction to this list differentiates the Indians of British Columbia from those of the Plains, and cautions one against drawing hasty conclusions of Japanese affinities or origin.

HARLAN I. SMITH.

The Systematic Position of Peripatus. — Since the discovery by Moseley of tracheæ in Peripatus, over twenty years ago, scarcely a doubt has been thrown upon the arthropod nature of this interesting animal. Recently[2] Boas, one of the most accurate students of the arthropods, has taken up the question of the affinities of the form in question, and after a careful consideration of its structure decides that it has nothing decidedly arthropodan in its make-up, but that in all deciding points it is clearly an annelid modified for a terrestrial life. It lacks the thick jointed cuticle characteristic of the arthropod, and its appendages are not arthropodan. It possesses the external circular layer of muscles which is not found in any true arthropod, and all of its muscles are of the smooth variety. The eyes are upon the annelidan type; the nephridia are numerous; the characteristic arthropodan hairs are lacking, while the claws, upon which so much weight has been placed, are built upon a different plan, being solid rather than hollow outgrowths.

A few points need more space. The jaws of Peripatus are modified appendages, according to both von Kennel and Sedgwick. Boas, however, points out that this jaw is but the terminal claw of Peripatus and is not the whole limb. He also calls attention to the relations of the parapodia to the mouth in the polynoid worms. The heart, like that of arthropods and unlike that of the annelid, is pro-

1 *A Preliminary Catalogue of the Collections of Natural History and Ethnology in the Provincial Museum, Victoria, British Columbia*, 1898, p. 196, is being issued.

2 *Kgl. danske Vidensk. Selsk. Forhandlingar*, 1898, No. 6 (1899).

vided with ostia and is placed in a pericardial sinus, but the ostia in Peripatus can be explained by the disappearance of the transverse vessels, while the pericardium is merely a blood sinus, the result of the atrophy of true circulatory tubes, these having degenerated as a consequence of the development of tracheæ. In regard to tracheæ, Boas points out that tracheæ of different kinds can exist, and that it has yet to be proved that those of Peripatus and those of the "Tracheata" are homologous; with the bulk of the evidence against the view. It is further emphasized that if Peripatus be a stem form for the "Tracheates," then, of necessity, the Arthropoda must form a polyphyletic group — in other words, the Arthropoda must go, for we cannot conceive how the Crustacea could have descended from insectan or myriapod ancestors. In this connection, see this journal, Vol. XXVIII, p. 230, 1894, and *Natural Science*, Vol. X, pp. 97 ff., 1897.

New York Amphibia.[1] — The Linnæan Society of New York has been issuing a series of bulletins on the local fauna of the surroundings of New York City. This work is one strongly to be commended. The *Naturalist* believes thoroughly in the importance of the study of local faunas. The present list describes 11 species: 1 Bufo, 1 Scaphiopus, 4 Hyladæ, and 5 Rana. Statements are also made concerning distribution, habitat, note, and egg-laying habits. The pamphlet will be valuable to teachers of zoölogy, as well as to investigators.

Adaptive Modifications in Respiratory Organs of the water-inhabiting mammals, especially the cetaceans, in response to their changed environment, have been investigated by O. Müller.[2] In most pronounced cases the trunk of the animal assumes the form of a spindle to accelerate movement through the water. The thorax is somewhat flattened dorso-ventrally, and the lungs, in which the lobes have been lost by fusion, are more extensively developed dorsally than ventrally. This is especially well seen in the bronchial branches, which, instead of being exclusively ventral, are often dorsal. The thoracic muscles are strong. The trachea is provided with complete cartilage rings instead of incomplete ones, as in most mammals, and the shortening

[1] Sherwood, W. L. The Frogs and Toads Found in the Vicinity of New York City, *Proc. Linn. Soc., New York*, No. 10, 27 pp., 1898.

[2] Müller, O. Untersuchungen über die Veränderungen, welche die Respirationsorgane der Säugetiere durch die Anpassung an das Leben im Wasser erlitten haben, *Jena. Zeitschr.*, Bd. xxxii, pp. 95–230, Taf. iii–vi, 1898.

of the neck often induces a fusion of ring with ring. The cartilage support for the bronchial tubes may be in the form of a spiral band, traceable well into the substance of the lung. Most of these adaptations are obviously means for resisting the enormous pressure of the water on the gas-filled cavities of the lungs, etc. G. H. P.

Reptiles of North America. — Under the title of *Contributions to North American Herpetology*, Mr. Robert Baird McLain, of Wheeling, W. Va., has published privately three memoirs on the collections of reptiles in the Museum of Stanford University. They are entitled "Contributions to Neo-tropical Herpetology," "Notes on a Collection of Reptiles made by C. J. Pierson at Fort Smith, Kansas," and "Critical Notes on a Collection of Reptiles from the Western Coast of the United States." All bear the date of February, 1899.

These papers are full of misprints; the form of statement is often crude, and the references to other authors, as Professor Cope and Dr. Van Denburgh, are characterized by the sweeping severity which extreme youth frequently displays towards the masters.

It might fairly be inferred from the nature of their contents that these papers had received the criticism and approval of the instructors of Stanford University. It is well to state, therefore, that they represent merely the laboratory notes of an undergraduate student who had free access to the museum shelves. That publication of these notes was contemplated was not learned until after Mr. McLain had left the institution, and their appearance in print is contrary to the advice of the officers of the museum, and despite their protest. One new species *Thamnophis steinegeri* (misprinted *rteinegeri*) is described and well figured. As the material has not yet been critically studied, the value of the species is yet to be determined.

D. S. J.

Zoölogical Notes. — Dr. Oscar Loew, who has recently been called to the Department of Agriculture at Washington, has just published at Munich a timely and valuable book of some 175 pages, entitled *Die chemische Energie der lebenden Zellen.*

"Movement of the Nervous Elements" (*Act. Soc. Scient. Chili.* Tome VIII, pp. 71–76) is the title of a critical review by Daniel Monfallet, of the more recently discovered facts and their bearings on the theories of Rabl-Ruckhard, Tanzi, and Ramon y Cajal, as to

the interaction of the nervous elements. The author concludes that our present knowledge on this subject is too scanty to afford any sound basis for generalizations.

The fourth number of Volume II of the *American Journal of Physiology* contains the following papers: "The Mechanism of the Motor Reactions of Paramecium," by H. S. Jennings; "On Absorption from the Peritoneal Cavity," by L. B. Mendel; "The Origin of the 'Traube' Waves," by H. C. Wood, Jr.; "Laws of Chemotaxis in Paramecium," by H. S. Jennings; and "The Chemistry of the Melanins," by W. Jones.

The hearts of several species of lungless salamanders were studied several years ago by Hopkins, who reported the absence of pulmonary veins, but the presence of an auricular septum. H. L. Bruner (*Anat. Anzeiger*, Bd. XV, No 22) has reinvestigated the subject, and finds no auricular septum present, but that the sinu-atrial valve is so placed as to be easily mistaken for such a septum, an error which he believes Hopkins to have fallen into.

Dr. Carlgren thinks (*Zool. Anz.*, Vol. XXII, p. 102) that the *Branchiocerianthus urceolus*, recently described by Mark, is a hydroid near Corymorpha.

Walter May contributes an excellent review of the classification and distribution of the Alcyonoid polyps to the *Jenaische Zeitschrift*, Bd. XXXIII. Many new species are described.

In his "Revision of the Squirrels of Mexico and Central America" (*Proc. Wash. Acad. Sci.*, Vol. I, pp. 15–106), Nelson recognizes forty-three species and subspecies.

"North American Fauna No. 14," issued by the *Biological Survey of the United States Department of Agriculture*, contains an account of the Natural History of the Tres Marias Islands, situated in the Pacific Ocean, not far from the Mexican coast. The mammals, birds, reptiles, crustaceans, and plants are dealt with, and the report concludes with a bibliography of these islands.

Cyathocephalus truncatus is the only known cestode characterized by the transformation of the entire scolex into a single bothrium. To this genus Riggenbach has just added a second species, *C. catinatus*, from *Solea vulgaris*.

Scolex abnormalities are very common in *Cœnurus serialis*, according to Railliet, *C. R. Soc. de Biol.*, Jan. 21, 1899, who found in a

single bladder, containing 246 scolices, only 217 normal. The abnormalities are grouped as follows: (1) simple diminution in the number of suckers, two heads having three each; (2) simple augmentation in the number, two heads having five suckers each, six, six each, one eight and one nine suckers; (3) double rostellum, two heads with two rostella each; (4) double rostellum with extra suckers also, two scolices with double rostella and six suckers each, one such with nine and one with ten suckers. If it be true that the heads with six suckers produce the triangular chains in the adult, as has been generally maintained, the author justly inquires what heads with three, five, eight, nine, and ten suckers will produce?

In a seal shot during the Swedish Arctic Expedition of 1898 were found abundant remains of a cephalopod, identified by Lönnberg (*Ofversigt, Kgl. Vet. Akad. Förh.*, 1898, No. 10, p. 791) as *Gonatus fabricii.* This demonstration of the use of cephalopods as food by the seal in its pelagic wanderings shows "that the cephalopods form an important link in the chain of marine organisms from the microscopic plankton to the mammals."

NEWS.

Sir William Turner, of Edinburgh, has been elected president of the British Association for the Advancement of Science for the meeting of 1900.

Dr. E. V. Wilcox has resigned the chair of zoölogy in the University of Montana and will accept a place in the Agricultural Department at Washington, where he will have charge of the zoölogical items in the *Experiment Station Record*, a position left vacant by the resignation of Dr. F. C. Kenyon.

The Scientific Alliance of New York now includes eight societies, with a total of over 1100 members. It has a research fund of $1200 and $10,000 towards the erection of a building for the accommodation of the constituent societies.

Dr. John W. Harshberger, instructor in botany in the University of Pennsylvania, invites subscriptions to his work, *The Botanists of Philadelphia and their Work.* The manuscript is complete and awaits subscriptions sufficient to make its publication possible.

The State University of Ohio maintains a lakeside laboratory this summer at Sandusky, Ohio. The laboratory is intended exclusively for investigation and no instruction is given. The station is under direction of Professor Herbert Osborn of the university.

A bronze bust of the late Increase A. Lapham was unveiled in the Public Museum of Milwaukee, March 7.

Dr. L. L. Hubbard has resigned his position as state geologist of Michigan.

The University of Nebraska receives $496,000 for the next two years, $93,000 of this being for buildings and improvements.

The University of Chicago has made the following appointments to fellowships for the ensuing year: Botany, A. C. Moore, B. E. Livingstone, S. M. Coulter, F. M. Lyon; Zoölogy, H. E. Davies, R. S. Lillie, F. M. Guyer, H. H. Newman; Neurology, D. M. Shoemaker; Physiology, R. R. Rogers, W. E. Garvey; R. W. Webster; Anthropology, A. W. Dunn; Geology, W. W. Atwood, W. N. Logan, R. George, W. T. Lee, W. G. Tight.

An index to the first thirty volumes of the *Jenaische Zeitschrift für Naturwissenschaft* has just been issued. A few months ago a similar index to Vols. XLI–LX of the *Zeitschrift für wissenschaftliche Zoologie* was published. Both indices are very complete and detailed.

Dr. F. W. C. Areschoug, for many years professor of botany in the University of Lund, Sweden, has resigned.

Professor Douglas Houghton Campbell, of Leland Stanford University, will spend the coming year in Europe, on leave of absence.

The next meeting of the American Society of Naturalists will be held at New Haven, Conn. Most of the affiliated societies have signified their intention of meeting at the same place.

Appointments: Marshall A. Barber, assistant professor of bacteriology in the University of Kansas. — Mr. Joseph Bancroft, a physiologist, fellow of King's College, Cambridge. — Dr. Bergen, professor of geology and mineralogy in the Mining School at Klausthal. — W. J. Blankinship, professor of botany in the Agricultural College of Montana. — Dr. W. von Branco, of Hohenheim, professor of geology and paleontology in the University of Berlin. — I. H. Burkill, assistant to the director of the Kew Gardens. — Dr. Calmette, professor of bacteriology in the medical faculty at Lille, France. — Dr. Otto Cohnheim, privat-docent for physiology in the University of Heidelberg. — Dr. Dove, professor of botany in the University of Jena. — Dr. Erich von Drygalski, professor of geography in the University of Berlin. — J. Dybowski, of Paris, director of the newly established Colonial Gardens at Vincennes, France. — Dr. Eggeling, privat-docent for comparative anatomy and embryology in the University of Strassburg. — Dr. Ferdinand Filarsky, custodian of the botanical section of the Hungarian National Museum at Budapest. — Dr. Hugo Fischer, privat-docent for botany in the University of Bonn. — Dr. Jakob Früh, professor of geography in the Zürich Polytechnicum. — Mr. E. E. Green, entomologist of the agricultural department of Ceylon, with headquarters at Peradeniya. — Dr. A. Y. Grevillius, assistant in botany in the Kempen (Germany) Agricultural Experiment Station. — Dr. David Frazer Harris, tutor in physiology in the University of St. Andrews, Scotland. — A. L. van Hasselt, professor of ethnology in the Indian Institute at Delft, Holland. — Dr. Curt Hassert, professor of geography in the University of Tübingen. — W. Botting Hemsley, director of the Kew Herbarium. — Dr. Anton Herrmann, privat-docent for anthropology in the University of Klausenberg,

Austria. — Dr. Moritz Hoemes, professor extraordinarius of prehistoric archæology in the University of Vienna. — Samuel J. Hunter, associate professor of entomology in the University of Kansas. — Dr. Georg Karsten, professor extraordinarius of botany in the University of Bonn. — Dr. Gustaf Adolf Koch, professor of geology in the Vienna Agricultural School. — Dr. Albert Krafft von Dellmensingen, of Vienna, assistant on the Geological Survey of India. — Dr. Maria, Countess von Linden, assistant in zoölogy in the University of Bonn. — Edward Alfred Minchin, of Oxford, tutor of biology in Guy's Hospital Medical School, London. — Dr. F. S. Monticelli, of Cagliari, professor of zoölogy in the University of Modena. — W. A. Murrill, assistant in cryptogamic botany in the Cornell Experiment Station. — Dr. W. Petterson, lector for mineralogy and geology in the Stockholm Technical School. — Dr. Frederico Raffaele, professor extraordinarius of zoölogy and comparative anatomy in the University of Palermo. — Dr. Fritz Regel, of Jena, professor extraordinarius of geography in the University of Würzburg. — Daniel E. Rosa, of Turin, associate professor of comparative anatomy in the University of Sassari. — Dr. Achille Russo, of Benevento, professor of zoölogy and comparative anatomy in the University of Cagliari. — Frederico Sacco, professor extraordinarius of paleontology in the engineering school at Turin. — Dr. Solomon, professor extraordinarius of mineralogy in the University of Heidelberg. — W. C. Stevens, professor of botany in the University of Kansas. — Professor J. Arthur Thompson, regius professor of natural history in the University of Aberdeen. — Professor A. E. Törnebohm, chief of the Swedish Geological Survey. — Swale Vincent, first assistant in the physiological laboratory of the University of Cambridge. — Professor F. L. Washburn, state biologist of Washington. — Dr. Engen Ph. Wotczall, professor of botany in the newly established technical school at Kieff, Russia. — Dr. Wilhelm Zopf, professor of botany in the academy at Münster, Germany.

Deaths: J. Hermann Albarda, ornithologist, in Leenwarden, Holland. — Theodor Beling, student of Diptera, in Seesen Brunswick, Germany, December 17. — Konstantin Busiakis, professor of physiology in the University of Athens. — Wilhelm Dames, professor of geology and paleontology in the University of Berlin, December 22, aged 55. — P. Alfred Feuilleaubois, fungologist, at Fontainebleau, France. — Charles Fortunn, mineralogist, in London. — Dr. Leopold Tausch von Glöckelsthurn, of the Austrian Geological Survey, January 2,

aged 40. — Dr. Gruby, a student of poisonous fungi, in Paris. — K. G. Henke, conservator of the zoölogical and ethnographical museum at Dresden, February 18, aged 68. — Friedrich Jeppe, geologist, in the Transvaal, August, 1898. — Dr. Heinrich Kiepert, professor of geography in the University of Berlin, April 21, aged 79. — Major Krüger-Velthusen, ornithologist, in Berlin, November 26. — Dr. Oliver Marcy, professor of natural history in Northwestern University, at Evanston, Ill., March 19, aged 79. — Alfred Paul Maupin, student of Coleoptera, in Paris, January 22. — M. Naudin, French botanist, aged 83. — William Burges Preyer, the well-known student of Lepidoptera, for twenty years settled in Borneo, at Port Said, Jan. 7, 1899, aged 55. — Joseph Stevens, geologist, April 7, aged 81. — Dr. Philipp J. J. Valente, a student of Central American archæology, in New York, March 16, aged 71. — Adolf Walter, ornithologist, at Kassel, Germany, February 5. — Aulis Westerlund, student of Hymenoptera, in Finland, December 7. — Paul Wladimirowitsch Jeremejew, formerly professor of mineralogy in the mining school at St. Petersburg, January 18, aged 68.

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(The regular Exchanges of the *American Naturalist* are not included.)

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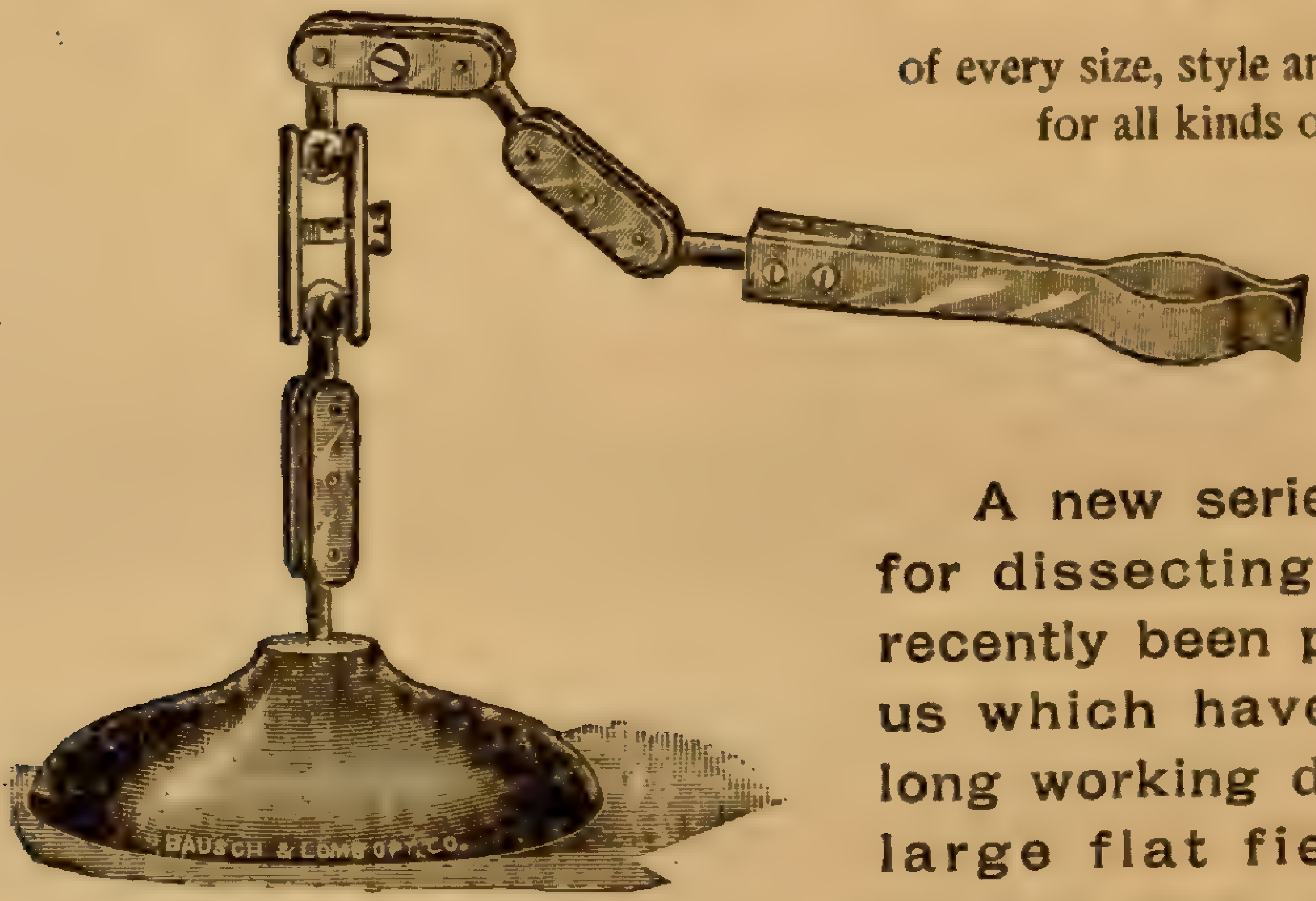

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All naturalists who have anything interesting to say are invited to send in their contributions, but the editors will endeavor to select for publication only that which is of truly scientific value and at the same time written so as to be intelligible, instructive, and interesting to the general scientific reader.

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THE HOPKINS SEASIDE LABORATORY.

VERNON L. KELLOGG.

THE Leland Stanford Junior University was formally opened to students Oct. 1, 1891. It is situated on the great Palo Alto estate, whose eight thousand acres carry this unusual college yard from the salt marshes of San Francisco Bay across the intervening valley and over the lesser hills to the foot of the climax of the Santa Cruz Mountains. In the summer recess after the first college year, Stanford had its marine laboratory ready for habitancy. A friend of the university, Mr. Timothy Hopkins, whose practical friendship has been especially enjoyed by the biological departments of the university, provided the money for building and equipping the laboratory, which, in honor of the founder, is officially named "The Hopkins Seaside Laboratory of the Leland Stanford Junior University."

The location chosen for the laboratory by the directors, Professors Jenkins and Gilbert, is the bay side of the promontory, Point Pinos, which is the southern limiting point of the Bay of Monterey. The bay is a great, shallow indentation of the coast line, which offers little protection from the sweep of the open ocean except in its southern part.

Here, on a cliff by the water's edge, are the laboratory buildings. They are two two-story buildings, one sixty feet long by twenty feet wide, the other forty by twenty-six feet. Two large salt-water tanks stand near by. Within, the space is divided into large and small laboratories, rooms for investigators, lecture room, photographic dark room, aquaria, concreted basement rooms, etc. The collecting equipment comprises the necessary dredges and nets, and instruments for sounding and for taking below surface temperatures. The

THE HOPKINS SEASIDE LABORATORY.

laboratory does not own a launch, a sailboat and rowboat having proved, so far, sufficient for the needs of the collectors. The collecting of fishes is chiefly done by Chinese fishermen, of whom a villageful lives but half a mile from the laboratory.

In addition to a fauna more or less peculiar to itself, the Bay of Monterey, being a middle point between the north and south zones of the Pacific coast, finds itself possessed of a number of sub-tropical and sub-boreal types peculiar to the two regions. The Pacific coast of the United States has but few bays; it is a straight coast line bathed by the great swell of the open ocean. In the aggregate the east coast, with its intricate coast line, will present a greater abundance of bay-

shore life, but area for area, the collecting ground about the Hopkins Laboratory is probably unapproached by any spot on the Atlantic coast. A well-known and experienced biologist of the University of Chicago, who spent a summer at the Hopkins Laboratory, has said that Monterey Bay and the Bay of Naples are much alike in the abundance and representation of species. It will be of interest to naturalists to be told in some detail of the actual faunistic conditions of the bay and ocean shore near the Hopkins Laboratory. The laboratory has been long enough established, and the observation and collecting diligently enough prosecuted, to make it possible to undertake this with some confidence. For the statements regarding the invertebrate fauna, I am presenting very largely the observations of Mr. Harold Heath, assistant professor of zoölogy in Stanford University.

The sponges are extremely abundant; in certain localities they encrust the rocks over a large area. There can be no less than thirty species represented. Among the hydroids two or three species also are very numerous, literally covering the rocks at extreme low-tide mark. Sea anemones are plentiful. Certain forms which cover themselves with shells and stones occur between tide marks closely packed together to the number of many thousands. Annelids are numerous, as are certain star worms (Gephyrea), but the vermian class has been as yet little studied. A species of Cirratulus, which lives in the cracks of the rocks, extends its long, thread-like tentacles up through the sand, so that in their abundance and massing they look like tufts of delicate seaweed.

Certain groups of mollusks are unusually well represented. Four or five species of Haliotis are abundant, and are used for food by the Chinese. Many are dried and shipped to China. Limpets are particularly well represented, as also are the nudibranchs, of which thirty or forty species have been noted. About thirty species of Chiton have been found, among them the giant Cryptochiton, six to ten inches long, the only one of the group with a concealed shell. Mytilus forms great beds at low-tide mark, and is used to some extent as food. Among the cephalopods certain species of Loligo are so abun-

dant that the catch of the Chinese fishermen for a single night, when spread out on the ground to dry, will cover five or six acres! The Chinese boats go out by night with nets and pitch-pine torches, which are hung over the boat's side to lure the squid. The squids are dried and shipped to China to be used as food. It is said also that the dried squids are used in China as fertilizer. The duty on fertilizer in China is very low, the duty on salt very high. By mixing a little dried squid with a great deal of salt, and calling it fertilizer, a considerable amount

COAST NEAR THE HOPKINS LABORATORY—VIEW FROM POINT LOBOS.

of salt finds its way into the Celestial Kingdom at a very low duty rate. The giant squid, *Ommatastrephes californica*, and a species of Octopus (punctatus, probably) occur, the latter quite common, and the former not infrequent during the summer, when the rock-cod are young and readily caught.

Crustacea are well represented in certain groups. Amphipods literally swarm everywhere. Isopods, particularly two species of Idothea, are very common. The Brachyura are represented by twenty to twenty-five species, while the Macrura are represented by three or four very numerous hermit crabs and an Alpheus. Copepods are numerous, wonderfully

so in the plankton. They are largely the cause of the phosphorescence of the ocean here. The water sometimes has a light rusty color, which is due to the occasional abundance of Noctiluca.

About sixty kinds of echinoderms have been found. The sea urchins cover the rocks in the strip of land from extreme low tide out for thirty to forty feet, and for distances of miles along the coast. Some of them are of enormous size. *Holothuria californica*, a sea cucumber from ten to twenty inches long, is abundant. A great orange-red Cucumaria, three feet long, is not uncommon. Serpent stars fairly swarm in the sand, together with Synapta. The starfishes are numerous, and there are many large and strikingly colored ones. The Chinese fishermen collect, can, and send to China, to be used as food, large quantities of the reproductive glands of the sea urchins.

Ascidians are as numerous as the sponges, and are found in the same places, encrusting the rocks over about the same areas. The compound forms are especially numerous, but large simple ones suitable for study are not so easily procured.

The fish fauna of the Bay of Monterey and adjacent waters presents numerous special features of interest. Hag-fish and Chimæra are easily collected in large numbers. The rock-cod, a group of peculiar oviparous forms, are abundant in species and individuals. The viviparous surf-fishes, found elsewhere only in Japan, are numerous. The embryos, when they issue from the body of the mother, are surprisingly large in proportion to the size of the adult female. The fish fauna is an unusually large one because of the presence of a number of sub-tropical forms, and many northern forms, in addition to the forms peculiar to the region.

At the extremity of Point Pinos peninsula, and along its rock-bound western or ocean side, there are a number of "bird rocks." These isolated rocks, rising twenty to forty feet above the water, are fairly covered at times with cormorants, pelicans, and gulls. In the breeding season the larger ones are occupied as rookeries by various sea birds. As there are no storms in summer, an excellent opportunity for observing the life of these sea birds is offered, and some extended studies,

especially of the migration of ocean birds, have been made here by Mr. Leverett M. Loomis, of the California Academy of Sciences.

The botanist, too, finds much of unusual interest on this bit of Pacific coast and in the bay and ocean waters of the shore. The Monterey cypress and Monterey pine, two conifers so restricted in their range as almost to warrant the statement that they are to be found naturally only on this little promontory, are the characteristic trees of the region. The cypress is, indeed, found only here, but the pine has a range of a hundred miles, perhaps, along the coast. Point Pinos is, however, the center and the principal point of its occurrence. In the shore waters the botanist is at once impressed with the abundance and enormous size of the brown kelps. *Macrocystis pyrifera* grows to the length of 1000 and 1500 feet; Nereocystis is nearly as large. A number of these brown kelps are monotypic, and are found only on the Californian coast. Among these forms is the interesting sea palm, Postelsia, which grows abundantly on the surf-swept rocks. The red algæ, too, are present in great abundance. In fact Professor D. H. Campbell says that in his acquaintance with the shore waters of America, Europe, Japan, and the West Indies he has found nowhere else so great a number of species, nor so enormous an abundance of individuals, as are displayed in these waters.

The laboratory's regular sessions are held in June and July of each year, but investigators and students working without instruction may continue their work through the summer. Courses in general zoölogy, embryology, and cryptogamic botany are regularly offered, with special courses and lectures depending upon the personnel of the instructing force. The instructors are chiefly members of the biological faculty of Stanford University. Students taking the regular courses are charged a fee of twenty-five dollars; investigators prepared to carry on original work are permitted the use of the laboratory and its equipment free of charge. There are seventeen private rooms for investigators.

The Hopkins Laboratory has a point in common with the Naples Station, which should not go unremarked. The laboratory can be used to advantage at any time in the year. The mid-year holidays always find a group of workers there.

THE NORTH-AMERICAN ARBOREAL SQUIRRELS.

J. A. ALLEN.

No attempt at a critical revision of the American arboreal squirrels has been made since 1878, but during the last two years several noteworthy contributions to this end have appeared, covering practically the Sciuri occurring north of Panama; but those of South America still await revision. The latest and by far the most important of these contributions is Mr. E. W. Nelson's recently published "Revision of the Squirrels of Mexico and Central America,"[1] which marks an epoch in the history of the subject. Mr. Nelson is not only a well-trained naturalist, but has several marked advantages over previous monographers in having at his command not only a far greater amount of material, but material incomparably better in character, and also an intimate acquaintance with the physiographic conditions of the region to which his studies relate, and with the animals themselves in life, gained through eight years' field experience in Mexico and Central America. He has not only thoroughly explored, in company with his assistant, Mr. E. A. Goldman, under the auspices of the United States Biological Survey of the Department of Agriculture, western Guatemala, but has traversed Mexico from sea to sea, and from north to south, on several different lines. Of the 919 specimens on which his monograph is based, more than 600 were collected by himself and assistant. During the preparation of his paper he was "able to examine representatives — and in most cases types or topotypes — of nearly all the known species and subspecies found in Mexico and Central America." The investigation, under such favorable conditions, of the large amount of excellent material at his disposal has led him to recognize 30 species and 13 subspecies as occurring between

[1] *Proc. of the Washington Acad. of Sci.*, vol. i, pp. 15–106, Pls. I and II. Published May 9, 1899.

the southern boundary of the United States and Panama, of which four only extend north of this boundary. In 1877 and 1878 the number recognized, respectively, by Allen and Alston, in their well-known papers on the American Sciuri, was 9 and 7. Not only, however, was the material then available comparatively scanty and poor in quality, but, as Mr. Nelson observes, these authors "were handicapped by the prevailing tendency of the time to lump species."

Under "Notes on Distribution and Variation" Mr. Nelson refers to the definiteness of the ranges of the various species, which is governed by the distribution of the different kinds of forest growth, which in turn is controlled by temperature and moisture.

In his review of the "Subgenera of North-American Species" Mr. Nelson recognizes 10 subgenera, of which four are here first characterized, namely, Baiosciurus, Aræosciurus, Otosciurus, and Hesperosciurus. Three of the 10 subgenera are practically confined to that portion of North America north of Mexico (one entirely so, and two others extending south of the United States only into northern Lower California); two are properly South American, while the remaining five are common to the United States and Mexico. These groups are characterized by differences in size and proportions, together with differences in the shape of the skull and in dentition, and seem to form natural groups, though in general but slightly differentiated. By far the greater part of the tropical forms (10 species and 13 subspecies) belong to the single subgenus Ehinosciurus, which is unrepresented north of Mexico.

According to Mr. Nelson: "Tree squirrels occur in suitable places throughout Mexico and Central America, but the distribution of the various species depends largely upon the character of the forests. Thus *Sciurus negligens* is most abundant in the low dense forests of ebony, less than twenty-five feet high, on the hot coast plains, while its near relative, *S. deppei*, loves the shady depths of the humid tropical forests on the lower mountain slopes where the damp air produces an exuberant tree growth and an abundance of parasitic plants. . . . The larger species exist under even more varied conditions, since they

occur from the hot coast country to the region of oaks and pines close to timber line, but the ranges of different species or subspecies are never coincident and overlap only in a few instances, as in the case of *S. colliæi nuchalis* and *S. poliopus colimensis* on the coast of Colima, and *S. apache* and *S. durangi* in the Sierra Madre.

"Many species change their environment by periodical migrations in search of food, moving from one locality to another with the ripening of fruits or seeds upon which they subsist. This is most marked on high mountains, where a species may have a vertical range of many thousand feet." Mr. Nelson also says: "The effect of climate on the character of the pelage is so marked that it is possible to tell with considerable certainty whether a species belongs to the tropics or to the high mountains. Tropical species have thin pelage, short, thin under fur, and coarse, stiff, or almost bristly, dorsal hairs. . . . These differences are sometimes strikingly shown in subspecies of the same squirrel." Seasonal differences, however, are slight, but individual variation, on the other hand, is often excessive, rendering some species extremely difficult to describe.

"The extraordinary amount of geographical variation in tropical North-American squirrels is due mainly to an unusual plasticity of the organization which allows slight climatic differences to produce visible effects. The most obvious of these influences are differences in temperature and rainfall, with their distribution through the year and consequent effect on vegetation." Thus in the drier interior mountains certain subspecies of a group will be characterized by dull grayish upper parts and white under parts, while other subspecies of the same group inhabiting humid mountains near the coast will have nape and rump patches sharply contrasting with the rest of the dorsal surface.and bright ferruginous under parts, increased humidity within the tropics being usually accompanied by increased intensity of coloration.

In this admirable paper Mr. Nelson attempted a most difficult task, which consisted in not only recognizing and defining the various forms of tree squirrels inhabiting tropical North America, but in clearing up the tangle of synonymy involved in the

works of previous authors. As a first step to this result he identified as far as possible the type localities of all the species previously described, and secured from them "topotypes"; and he was further greatly aided by Mr. Oldfield Thomas, of the British Museum, in determining many of Gray's imperfectly described species. While it is too much to expect that Mr. Nelson's revision will be final, especially as regards the Central-American forms, his paper is of the highest importance as a contribution towards reducing to comparative order the chaos that has hitherto prevailed in this difficult field. As a result of his determinations several radical changes of nomenclature have been necessary, including the proper allocation of Erxleben's *Sciurus variegatus*, which has proved so great a source of trouble to previous writers, but which Mr. Nelson has conclusively shown belongs, not to any species of Sciurus, but to a species of Spermophilus! Great credit is due Mr. Nelson for his well-planned and intelligent work in the field, as well as for the careful elaboration of his material and the clear and workmanlike way in which he has presented his results.

In addition to Mr. Nelson's revision of the squirrels of tropical America, two recent contributions have been made to our knowledge of the squirrels of North America north of Mexico.

In December, 1896, Mr. Outram Bangs published "A Review of the Squirrels of Eastern North America,"[1] which included the flying squirrels as well as the ordinary tree squirrels. This paper gave, under the genus Sciurus, four species and six subspecies, three of the latter being described as new, to which Mr. Bangs has since added another subspecies.[2]

The squirrels of western North America have not, as a whole, been recently revised, although much has been incidentally written about them, and several new forms have been described. The chickarees, or red squirrels (subgenus Tamiasciurus), were recently monographed by the present writer.[3] In

[1] *Proc. Biol. Soc. Wash.*, vol. x, pp. 145–167. Published Dec. 28, 1896.

[2] Sciurus (Tamiasciurus) gymnicus, *Proc. N. Engl. Zoöl. Club*, vol. i, p. 28. Published March 31, 1899.

[3] Allen, J. A. Revision of the Chickarees, or North-American Red Squirrels (subgenus Tamiasciurus), *Bull. Am. Mus. Nat. Hist.*, vol. x (1898), pp. 249–298. Published July 22, 1898.

this paper four species and 13 additional subspecies were recognized, four of the latter being described as new.

The last complete revision of the arboreal squirrels of North America north of Mexico was made in 1877,[1] when six species and seven additional subspecies were recognized. Since that date not only has a large number of new forms been added and important changes in nomenclature been made, but the point of view has become radically changed through the accumulation of a vast amount of additional and far better material than was available twenty years ago. In consequence of this it may be a convenience to those interested in our mammals to give in this connection a list of the 10 species and 25 additional subspecies of arboreal squirrels, now recognized by experts as found north of Mexico, with a brief statement of their ranges.

Arboreal Squirrels Found in North America North of Mexico.

Subgenus Hesperosciurus Nelson.

1. *Sciurus griseus* Ord. California gray squirrel. Southwestern Washington, western Oregon, and California.

1*a*. *Sciurus griseus nigripes* (Bryant). Coast region of California south of San Francisco.

1*b*. *Sciurus griseus anthonyi* Mearns. Anthony's gray squirrel. Interior of southern and lower California.

Subgenus Neosciurus Trouess.

2. *Sciurus carolinensis* Gmel. Southern gray squirrel. Eastern United States, from southern New York to northern Florida.

2*a*. *Sciurus carolinensis leucotis* (Gapper). Northern gray squirrel. Northern Alleghanies, and northward to New Brunswick and southern Canada.

2*b*. *Sciurus carolinensis hypophæus* Merriam. Merriam's gray squirrel. Minnesota and Wisconsin.

2*c*. *Sciurus carolinensis fuliginosus* (Bachman). Bayou gray squirrel. Coast region of Louisiana.

2*d*. *Sciurus carolinensis extimus* Bangs. Southern half of Florida.

Subgenus Otosciurus Nelson.

3. *Sciurus aberti* Woodhouse. Abert's squirrel. Mountains of Colorado, New Mexico, and Arizona.

3*a*. *Sciurus aberti concolor* True. Northeastern Colorado.

[1] Allen, J. A. *Monog. N. Am. Roden.* (1877), pp. 633–778, *passim.*

Subgenus Parasciurus Trouess.

4. *Sciurus niger* Linn. Southern fox squirrel. Virginia to southern Florida, east of the Alleghanies, and along the Gulf coast to eastern Louisiana.

5. *Sciurus ludovicianus* Custis. Western fox squirrel. Mississippi Valley, from Louisiana to Michigan, and from the western edge of the Alleghanies to the eastern border of the Plains.

5*a*. *Sciurus ludovicianus vicinus* Bangs. Northern fox squirrel. Mountains of West Virginia northward into western Pennsylvania. Formerly from northern Virginia north to southern New York and southern New England; now extirpated, except at the localities above indicated.

5*b*. *Sciurus ludovicianus limitis* (Baird). Texas fox squirrel. Texas, south into northeastern Mexico.

Subgenus Aræosciurus Nelson.

6. *Sciurus apache* Allen. Apache squirrel. Chiricahua Mountains, Arizona, south into Mexico in the Sierra Madre to Durango.

7. *Sciurus arizonensis* Coues. Arizona squirrel. Mountains of central Arizona.

7*a*. *Sciurus arizonensis huachuca* Allen. Huachuca squirrel. Huachuca Mountains, southern Arizona, south into Sonora.

Subgenus Tamiasciurus Trouess.

8. *Sciurus hudsonicus* (Erxl.) Northern chickaree. Canada, north of Ontario and Quebec, east of the Rocky Mountains, and Alaska.

8*a*. *Sciurus hudsonicus gymnicus* Bangs. Northern New England, northern New York, and southern Canada, including New Brunswick, Nova Scotia, Quebec, and Ontario.

8*b*. *Sciurus hudsonicus loquax* Bangs. Southern chickaree. From southern New England, southern New York, and the vicinity of the Great Lakes, south to Virginia, and in the Alleghanies to North Carolina.

8*c*. *Sciurus hudsonicus minnesota*, subsp. nov.[1] Minnesota chickaree.

[1] In my revision of the chickarees (*loc. cit.*) I called special attention to the small size of the chickarees examined from New Hampshire, northern Maine, New Brunswick, and Nova Scotia, and the large size of those from southern Minnesota and Wisconsin, these two phases presenting the extremes in size among the chickarees of eastern North America. They also differ a little in color when series of the two forms are compared, the small Eastern one being somewhat darker than the large Western one. As, however, they grade so insensibly into the Southern (*S. h. loquax*) and Northern (true *S. hudsonicus*) chickarees, respectively, it then seemed to me not worth while to recognize in nomenclature forms so hard to define, either in physical characteristics or geographically. Now that

Minnesota and Wisconsin, and probably Iowa, and eastward to northern Indiana.

8*d*. *Sciurus hudsonicus dakotensis* Allen. Black Hills chickaree. Black Hills, South Dakota, and adjoining portions of Wyoming.

8*e*. *Sciurus hudsonicus baileyi* Allen. Bailey's chickaree. Mountains of central Wyoming and eastern Montana, and northward into Alberta.

8*f*. *Sciurus hudsonicus ventorum* Allen. Wind River Mountains chickaree. Wind River Mountains and northward along the eastern base of the Rocky Mountains in Montana.

8*g*. *Sciurus hudsonicus richardsonii* (Bachman). Richardson's chickaree. Western border of northern Montana, central and northern Idaho, northeastern Washington, and northward into southeastern British Columbia.

8*h*. *Sciurus hudsonicus streatori* Allen. Streator's chickaree. From the central part of northern Washington northward over central British Columbia.

8*i*. *Sciurus hudsonicus vancouverensis* Allen. Vancouver chickaree. Vancouver Island, and northward along the coast to Sitka.

9. *Sciurus douglasii* Bachman. Douglas's chickaree. Coast region of Oregon and Washington.

9*a*. *Sciurus douglasii mollipilosus* (Aud. & Bach). Redwood chickaree. Coast region of northern California (= *Sciurus hudsonicus orarius* Bangs, 1897).

9*b*. *Sciurus douglasii cascadensis* Allen. Cascades chickaree. The Cascades region of Oregon and Washington, north into British Columbia.

Mr. Bangs has given a name to the small Eastern form, and left under *S. h. loquax* the large Minnesota one, it seems admissible, and perhaps advisable, to also name the large Western form.

Mr. Bangs has defined his *S. h. gymnicus* as: "Size smallest; hind foot small; colors all very dark," etc. He gives the size as: "Total length, 300; tail vertebræ, 117; hind foot, 47 mm."

S. h. minnesota may be characterized as size largest of the Eastern chickarees; hind foot large; colors lighter, etc. Total length, 345; tail vertebræ, 143; hind foot, 50 mm. Type, No. 4374, *Am. Mus. Nat. Hist.*, ♀ ad., Fort Snelling, Minn., April 4, 1890. Collected and presented by Dr. Edgar A. Mearns.

Mr. Bangs gives the average measurements of 6 adult topotypes of his *S. h. gymnicus* as: "Total length, 290.2; tail vertebræ, 121.2; hind foot, 44.5 mm. The measurements of 20 topotypes of *S. h. minnesota* measure: Total length, 334; tail vertebræ, 130.2; hind foot, 49.2 mm.

Mr. Bangs also gives the average measurements of 10 adults of *S. h. gymnicus* from Digby, Nova Scotia, presumably from his own collection, which by a singular coincidence agree to a millimeter in all the measurements with a series of the *same number* of specimens, from the *same locality*, given by me in my paper on the chickarees (*loc. cit.*), published nine months earlier.

In comparison with *S. h. loquax* the Minnesota form is as much larger than *S. h. loquax* as *S. h. gymnicus* is smaller, while the color differences are quite as tangible.

9*c*. *Sciurus douglasii albolimbatus* Allen. California chickaree. Sierra Nevada region of California, north into Oregon, east of the Cascades (= *Sciurus hudsonicus californicus* Allen, 1890).

9*d*. *Sciurus douglasii mearnsi* (Townsend). Mearns's chickaree. San Pedro Martir Mountains, Lower California.

10. *Sciurus fremonti* Aud. & Bach. Fremont's chickaree. Mountains of Colorado, north to the southern border of Wyoming, and west to the Uinta Mountains.

10*a*. *Sciurus fremonti neomexicanus* Allen. Taos chickaree. New Mexico.

10*b*. *Sciurus fremonti mogollonensis* (Mearns). Arizona chickaree. Mountains and higher plateaus of central Arizona.

As shown above, the subgenus Hesperosciurus is represented by a single species and an additional subspecies; the subgenus Neosciurus is also represented by a single species with four additional subspecies; the subgenus Otosciurus has a single species and an additional subspecies in the United States, and a second species in Mexico; the subgenus Parasciurus has two species and two additional subspecies; the subgenus Aræosciurus has two species and an additional subspecies in the United States, and three additional species and one subspecies in Mexico; Tamiasciurus has three species and 15 additional subspecies.

All the *species* of North-American Sciuri are sharply differentiated; the numerous *subspecies* represent for the most part well-marked geographical forms, which characterize more or less natural physiographic areas. In many cases the subspecies, in their extreme phases of development, are strongly differentiated, yet coalesce so completely at intermediate points as to be unsusceptible of sharp definition. They, however, represent stages in the evolution of species, and are facts that may be conveniently made note of by the brief formula of a trinomial name.

ALVIN WENTWORTH CHAPMAN.

WILLIAM TRELEASE.

Dr. Alvin Wentworth Chapman, whose *Flora of the Southern United States* has been the only handbook at all useful for a study of the botany of that interesting region for the past thirty years, died at his home in Apalachicola, Florida, on the sixth of April.

No name has been so familiar to the present generation of botanists in the South Atlantic region as that of Dr. Chapman, and yet few botanists now living ever saw him. In the interesting little city at the mouth of the Apalachicola River, where he died, far removed from railroads and the bustle of great manufactures and commerce, he lived a life of seclusion for over half a century; and as he rarely traveled, and the slowness of river and bay transportation make a journey of several days necessary from even the nearer gulf and coast cities before his home is reached, few visitors found their way to him. As a correspondent, even, he was known to relatively few now living. And yet by those who knew him personally, or through his letters, he was beloved to an unusual degree.

Alvin Wentworth Chapman. 1809–1899.

Though a resident of Florida since 1835, Dr. Chapman was originally a New Englander. He was born at Southampton, Mass., Sept. 28, 1809. He graduated at Amherst in 1830, and passed the next few years as a teacher in Georgia and North Carolina. His medical education was completed in Kentucky,

where, at Louisville, in 1835, he took a medical degree. In 1886 the University of North Carolina honored him and itself by conferring on him the degree of Doctor of Laws.

Soon after settling in Florida, Dr. Chapman made the acquaintance of Stephen Croom, at that time an active student of botany, —for whom the genus Croomia was named, — who interested him in the work to which the greater part of his life was to be devoted.

Though he had removed to the South with the intention of making it his home, had married a southern lady, and had resided in the South for a quarter of a century, Dr. Chapman was loyal to the Federal Government when the Civil War came; and though he refused to leave his chosen home, he did not lead a happy life during the continuance of the war. After its conclusion he occupied for a time several municipal and Federal offices in Apalachicola, but the later part of his life was passed in the quiet pursuit of the science to which he was devoted.

In 1860 appeared the first edition of his *Flora of the Southern United States*, concerning which it is said that his friend of many years, Professor Asa Gray, saved the plates from destruction during the troublous times of the war then beginning. A supplement, containing such corrections and additions as had come to his knowledge, was published in 1883. Subsequently (in 1897), as the result of continuous application, a considerably enlarged and entirely revised edition was issued.

Dr. Chapman's original herbarium, which may be considered as the most typical representation of the material on which his *Flora* rested, was many years ago added to the collections at Columbia University. Some years since a second herbarium, which had served as the basis of his revisions, was acquired by the Biltmore establishment, which also purchased the principal part of his library.

On the completion of the revised edition of the *Flora*, and under the burden of more than fourscore years, it might be thought that Dr. Chapman would have abandoned active botanical work. Not so, however. Each season saw him eagerly in the field looking for new facts and gathering new species. Not many years since, to further the work of a much younger man,

he went into the woods, a hundred miles from home, in mid-winter, and made an extensive collection of woody plants in their resting state, finding, as he wrote, no little pleasure in making the acquaintance of many old plant friends in an unwonted guise; and several of the larger herbaria are enriched by the fruits of his work in the field during the last five years of his life. Early in 1898 he went to a favorite collecting ground at Aspalago, just below where the Flint and Chattahoochee rivers join to form the Apalachicola, and had entered upon the preparation of a suite of the beautiful specimens for which he was noted, when an attack of vertigo, the true significance of which he well knew, ended his active labors. "At the age of fourscore years and ten," he wrote, "I have closed the book." And, indeed, from the time of his return from his last collecting trip until death put a final term to the activity of his mind, he was, perforce, content to thumb over and arrange the material in his hands, and to hope that others might make of it that use which was denied him. And yet he did not admit even to himself that he could do no more. The writer had the privilege of a long-promised and long-deferred visit to him shortly before the holidays last winter, and could scarcely prevent him from running out "only about a mile" to point out the habitat of a rare and local shrub. "Come back in the spring," said he, "and I 'll try and be well enough to show you some of my collecting grounds, — though," he added, "I 'll not take you to my boarding places there, for I don't think you could stand them." And even within a month of his death he walked nearly three miles to secure a desired specimen.

Few men have the natural endowment of so great modesty and disposition to retirement as Dr. Chapman possessed. His herbarium specimens are commonly marked "So. Fl.," to indicate that they were accepted in his *Flora* as properly bearing the names on the labels; but his own name rarely appears on his earlier labels, and is found appended to few published plant names. Running over his last spring's collections with the writer last winter, as one novelty after another was passed in review and its characters indicated, he would say: "But, you know, even if I were not at the end of my work, I should prefer

some one else to name them. I never did care to name species, and so many others do."

At one time in possession of a fairly good fortune, Dr. Chapman was unfortunate in the failure of a bank to which he had intrusted his money, and a sore trial — indeed, the only severe one — of his later years was his inability to foresee where he could get the considerable sum of money needed for the publication of the last edition of his *Flora*. That a friend was found in this time of need, did much to lighten the care of his latest years, in which his wants were of the simplest and most easily gratified, and is not forgotten by those who know the circumstances.

SYNOPSES OF NORTH-AMERICAN INVERTEBRATES.

II. GORDIACEA (HAIR WORMS).

THOMAS H. MONTGOMERY, JR.

THE hair worms have been classed by most writers as allies of the nematodes, based mainly on the similarity in external appearance and in the structure of the body muscular wall. The following comparison of more important structural characters, however, shows that these two groups are only very distantly related, if they are at all genetically connected:

Gordiacea: Body cavity lined by a peritoneum and transversed by dorso-ventral mesenteries; two testes in the male; genital aperture in the female united with the anal aperture (forming a cloaca); the brain has a narrow dorsal and a large ventral commissure, from which passes caudad an unpaired ventral nerve (with a ganglionic thickening at its posterior end), no dorsal median nerve being present.

Nematodes: Body cavity not lined by a peritoneum, and not transversed by mesenteries; one testis in the male; the genital aperture in the female is never united with, but always anterior to, the anal aperture; the brain is a simple ring around the œsophagus, and from it pass caudad a dorsal and a ventral median nerve.

Vejdovský regards the Gordiacea as degenerate annelids, basing his view on the metameric arrangement of the ovaries, the structure of the body cavity, and the presence of the single ventral nerve. But until the embryology of the hair worms is better known, their affinities must remain problematical.

The curious marine worm, Nectonema, whose structure has been described by H. B. Ward (*Bull. Mus. Comp. Zoöl.*, XIII, 3, 1892), has been regarded by this writer as allied to the Gordiacea. But while this affinity seems quite probable, it

cannot be considered proved until the structure of the genital organs of Nectonema is better known, and on this account I do not now include Nectonema among the Gordiacea.

The hair worms are in the adult stage fresh-water forms, very long and slender, with a thick cuticle on the surface of the body, without external segmentation or appendages. They are cylindrical in form, but become flattened after the discharge of the genital products. The head end usually tapers to a point, while the form of the posterior end differs in the two sexes. There are certain genera of nematodes (such as Mermis and Filaria) which bear a close external resemblance to them, but a mature hair worm may be recognized by the following peculiarities: The greater portion of the body is of the same diameter, the posterior end is never sharply pointed, and the surface of the cuticle is marked by elevated areoles or papillæ (the latter often complex in structure), or, by intersecting layers, is divided into rhombs.

The eggs are laid in the water in the form of long strings. From the egg develops a minute larva, characterized by a proboscis armed with hooks, which swims in the water for a short while, then enters into an aquatic insect, usually the larva of a may-fly. The larval stage ends at this point, and the embryonal commences. After a period the still immature and very small worm passes into a new host, most frequently the imago of a coleopterous insect, in the body cavity of which it may complete its development. The mode by which the worm passes into the second host seems to be dependent entirely upon environmental circumstances. In such a case where the first host is the larva of a may-fly, and the second a carnivorous beetle, it has been suggested that in a season of drought, when the pools become dried up, the may-fly is left stranded, and so becomes the easy prey of a beetle, the latter in eating the may-fly larva thus swallowing the young hair worm. But very frequently immature and nearly mature hair worms occur in the body cavity of orthopterous insects, such as grasshoppers and crickets, which are purely herbivorous, and which would probably never consume may-fly larvæ. For these cases two explanations occur to me by which to explain the

transference of the worms into herbivorous insects: (1) The second host, the carnivorous beetle, may die, and at its death the parasitic hair worm pass into a mass of decaying vegetation, and then be inadvertently swallowed by the cricket or grasshopper; or (2) the may-fly larva dies, and the worm after passing out of its body is swallowed by the orthopterous insect. In the first case the herbivorous insect would be the tertiary, in the second the secondary host. Probably at least one change of host always occurs, but there would seem to be no fixed regularity in regard to the sequence of hosts, nor in regard to the species of the host, for it would seem that embryos of the same species of hair worm are able to grow and develop in a variety of hosts. From the body cavity of the final host the worm, now nearly mature, but with its mouth stopped by a cuticular plug so that it can take no further nourishment, escapes in the water again, there to swim about for a time, and there finally to deposit its egg. We have seen that the final host is usually a terrestrial insect; for the worm to reach the water to lay its eggs there, it is necessary that its host, by a rainstorm or flood, become drowned in a body of water.

Probably but a small percentage of the hair worm larvæ ever arrives at the mature condition, since their transmission from host to host, and back to the water again, is so much a matter of environmental chance. There is opportunity for a great deal of study, with promise of interesting results, on the life history of these forms. By a wise provision of nature the genital products ripen prematurely, so that the individuals can reproduce themselves before they themselves are structurally adult.

Hair worms in North America have been found in the nearly mature but still parasitic stage, in Orthoptera (crickets, grasshoppers, Ceutophilus), in beetles (rapacious genera, such as Harpalus), and (rarely) in spiders and Lumbriculus. In other lands they have been found in other groups of insects, in snails, rarely in vertebrates, where their presence is probably purely accidental, as it certainly is in man. In the mature free state they occur in small ditches, small streams, sometimes springs (as *Gordius lineatus*), and large lakes. They appear to be very

irregular and sporadic in occurrence, so that one usually comes upon them accidentally. Occasionally 50 or 100 more individuals are found forming an interlacing ball.

As to the preservative methods, strongly penetrating fluids must be employed, owing to the thick cuticle encircling the body; for good histological fixation it is best to use Flemming's fluid, after cutting the worms into short segments.

The following key is for the species thus far described of the North-American continent, including Mexico; no specimens are yet described from the southeastern United States, nor from north of the United States. We have three well-marked genera: Gordius Linn., Chordodes (Creplin) Möbius, and Paragordius Camer. (Montg.). The females are, as a rule, more difficult to determine than the males, and the females of *Gordius platycephalus* and *G. densareolatus* are often barely distinguishable, while their males may be easily distinguished. This key enables one to readily distinguish the genus and sex, the species of the male individuals, and the females, except those of the genus Gordius, which must be determined by reference to more detailed descriptions. The males of *Chordodes morgani* and *Gordius leidyi*, and the females of *G. longareolatus*, *G. aquaticus difficilis*, and *Chordodes puerilis* are still unknown. *Chordodes puerilis* and *C. morgani* may eventually be found to be the two sexes of the same species.

In the following literature list the papers by Montgomery contain full descriptions of the American species (with figures), as well as references to all previous writings upon them; and the other papers mentioned are the chief systematic monographs on the group: —

1. Camerano: "Monografia dei Gordii." *Accad. Reale delle Sci. di Torino*, 1897.

2. Montgomery: "The Gordiacea of Certain American Collections." *Bull. Mus. Comp. Zoölogy*, Harvard, Vol. XXXII, 1898.

3. Montgomery: *Ibid.*, Pt. II. *Proc. Cal. Acad. Sci.*, 3d Ser., Vol. I, 1898.

4. Römer: "Beitrag zur Systematik der Gordiiden." *Abhandl. Senckenberg. naturforsch. Ges.*, Bd. XXIII.

5. Villot: "Monographie des Dragonneaux (Genre Gordius, Dujardin)." *Arch. Zoöl. gén. et expér.*, Vol. III.

6. Villot: "Révision des Gordius." *Annal. Sci. Nat.* (7) 1.

Key for the Determination of American Gordiacea.[1]

I. Posterior end trilobed, *Paragordius varius* (Leidy), ♀.

II. Posterior end bilobed, spirally enrolled (Paragordius and Gordius), ♂ ♂.

A. A sharp, *V*-shaped ridge behind the cloacal aperture.

a. The cuticle marked with large white spots. *Gordius aquaticus* (Linn.), ♂.

b. The cuticle not marked with white spots.

1. A parabolic line of hairs on the tail lobes. *G. a. difficilis* (Montg.), ♂.

2. No line of hairs on the tale lobes. *G. a. robustus* (Leidy), ♂.

B. No sharp, *V*-shaped cuticular ridge behind the cloacal aperture.

a. A longitudinal line of hairs on each side of the cloacal aperture. *G. lineatus* (Leidy), ♂.

b. No line of hairs on each side of the cloacal aperture.

1. Head end obliquely truncated. *Paragordius varius* (Leidy), ♂.

2. Head end not obliquely truncated.

a. Conical spicules behind the cloacal aperture.

1. Tail lobes short, thick, nearly conical. *Gordius densareolatus* (Montg.), ♂.

2. Tail lobes nearly cylindrical. *G. longareolatus* (Montg.), ♂.

b. No conical spicules behind the cloacal aperture, tail lobes cylindrical. *G. platycephalus* (Montg.), ♂.

III. Posterior end spirally inrolled, but not lobed, narrower than the preceding portion of the body, with a depression or groove on its ventral surface. Chordodes, ♂ ♂.

A. Cuticular areoles longer than high, on and between them small circular pits. *Chordodes occidentalis* (Montg.), ♂.

B. Cuticular areoles higher than long.

a. Spines on the summits of the highest areoles (papillæ). *C. puerilis* (Montg.), ♂.

b. No spines on the summits of the highest papillæ. *C. morgani* (Montg.), ♂.

IV. Posterior end not spirally inrolled, not lobed, not of less diameter than the preceding portion of the body. Chordodes and Gordius. ♀ ♀.

[1] The *American Naturalist* will undertake to determine and return any specimens that cannot be placed in the keys, and solicits correction and criticism for future revision.

A. Posterior end not noticeably enlarged. Gordius, ♀♀.

a. With elevated cuticular areoles on the whole surface of the body.

1. With paired dark stripes in the median lines. *G. leidyi* (Montg.), ♀.

2. No dark stripes in the median lines.

a. Areoles elongated in the long axis of the body, well separated from one another. *G. longareolatus* (Montg.), ♀.

b. Areoles not elongated in the long axis of the body.

1. Areoles closely apposed, tending to produce longitudinal ridges. *G. lineatus* (Leidy), ♀.

2. Areoles more or less confluent, tending to produce transverse rows; head usually cylindrical. *G. densareolatus* (Montg.), ♀.

3. Areoles usually separated, interareolar groups of fine hairs, head usually flattened. *G. platycephalus* (Montg.), ♀.

b. Without elevated cuticular areoles on the whole surface of the body.

1. No cuticular areoles.

a. Cuticle marked with white spots. *G. aquaticus* (Linn.), ♀.

b. Cuticle without white spots. *G. a. robustus* (Leidy), ♀.

2. Cuticular areoles at the ends of the body only. *G. a. difficilis* (Montg.), ♀.

B. Posterior end swollen, somewhat knob-shaped, slightly constricted off. Chordodes, ♀♀.

a. Cuticular areoles longer than high, on and between them small circular pits. *Chordodes occidentalis* (Montg.), ♀.

b. Cuticular areoles higher than long.

1. Spines on the summits of the highest areoles. *C. puerilis* (Montg.), ♀.

2. No spines on the summits of the highest areoles. *C. morgani* (Montg.), ♀.

AN ABNORMAL WAVE IN LAKE ERIE.[1]

HOWARD S. REED.

On July 19, 1895, between 8 and 9 P.M., in the vicinity of Erie, Pa., the waters of Lake Erie suddenly rose in a single wave about six feet high, which advanced upon the shore and after a few moments quietly subsided to their former level. Five miles west of Erie the rise was but three or four feet, and three distinct rises were observed; the first and second rises were about fifteen minutes apart, the second and third about half an hour apart. Fifteen miles east of Erie the rise was about six feet, and but one wave was observed.

The weather on the day referred to was calm and clear where the rise occurred, and had been pleasant on each of the two preceding days, with light variable winds most of the time, and a range of temperature from 80° to 90° *F.*

On the evening of the 19th the sky was cloudy, as if a storm were approaching. All day long the lake had been very calm.

Mr. R. J. Moorehead thus describes the phenomenon, as observed off North East, Pa.:

"Between eight and nine o'clock, while we were sitting near the shore of the lake, the water suddenly rose about six feet, vertically, running back on the beach about sixty feet. But for the sharply shelving beach just at the water's edge, many would undoubtedly have been drowned.

"The day had been calm, no wind, thermometer 91° *F.* in the afternoon.

[1] The writer wishes to acknowledge his obligations for information to Willis L. Moore, Chief of Weather Bureau, U. S. Department of Agriculture; R. F. Stupart, Director of the Meteorological Service of the Dominion of Canada; Commander E. H. Glenn, Acting Hydrographer, U. S. Navy Department; R. J. Moorehead, North East, Pa.; W. E. Hartt, West Millcreek, Pa.; P. A. Sanborn, North East, Pa. He is also indebted to I. C. Russell, Professor of Geology in the University of Michigan, for friendly suggestions and criticisms.

"When the water subsided, it receded to a distance of fifty-six feet out beyond its normal margin. I paced it during the comparative repose following the recession of the flood, though in a very few minutes it began to assume its normal condition. The flood and outflow did not occupy over a very few minutes, I should say not over five minutes.

"This was followed by calm (no wind during this time) for about ten minutes, when we heard a low ominous roar, gradually increasing in volume, which we knew was the wind coming down the lake; the first visible evidence of it was of wave after wave chasing each other with cumulative force, *directly down the lake*, nearly at right angles with the shore. Every wave was crested, and coming so swiftly (they went like a pack of hounds) that when they struck the rock-bound shore, one hundred yards below us, they took a tangent to the northeast; thus driving their foaming mass out, into, and diagonally across the waves whose course, not having been diverted, was due east, and caused this agitated mass of water to rear and plunge, traveling swiftly like a thing of life, out as far as we could see, as it was now becoming dusk, though still light."

A young man who was bathing in the lake at that point says that the water which came in was very cold and seemed very heavy compared with that which it displaced.

This strange behavior of the lake excited no little comment at the time, and many were the conjectures made to explain the phenomenon. The older people related a similar occurrence which took place some fifty years ago and drowned sheep in lowland pastures.

The 19th of July opened with threatening weather at all stations at the western end of the lake. Between 2.15 and 4 A.M. rain fell at Detroit and at Toledo. At 8 A.M. the observers at Detroit and Erie reported a south wind; the other stations reported a southeast wind. The average velocity of the wind was about seven miles an hour. The barometer was highest at Buffalo, gradually becoming lower toward the western end of the lake. At most of the stations the thermometer was above 90° *F.* at some time during the day, and the muggy atmosphere made the heat the more depressing.

The first indication of any unusual disturbance was at 1.10 P.M., when a small tornado struck the town of St. Clair, Mich. Trees were blown down by the hundreds, and about a dozen houses were seriously damaged. The wind was accompanied by a driving, soaking rain which lasted about thirty minutes. But the tornado was seemingly local in character, as the wind at Marine City, Lenox, and Memphis (near-by towns) was but a zephyr. It is doubtful whether this local stationary storm had any influence directly upon the meteorology of the surrounding country, although it may have started upper air currents, which might have produced results later, especially if it caused high westerly currents.

According to Davis, thunderstorms are often caused in this way, when the higher members of westerly currents overrun the southerly winds for a considerable distance eastward of the line which separates the two winds at the surface of the earth.

At 4.15 P.M., at Detroit, the first thunder of an approaching thunderstorm was heard, and at about 4.30 heavy rain began to fall, ending at 6.40 P.M.

At Toledo the wind had been generally southwest until 4.30 P.M., when a squall suddenly increased it to a gale from the northwest. The flagstaff halyards at the observing station were blown loose and caught around the cups of the anemometer, holding them fast and causing a loss of record until 7.50 P.M. It is estimated that the wind attained a velocity of forty-two miles per hour, with an extreme of sixty, during the first ten minutes of the squall. The barometer fell slowly until 4.20 P.M., then rose suddenly 0.07 inches and remained nearly stationary the rest of the day. The temperature rose rapidly during the day; just before the squall it registered 93°, but fell to 71° *F.* from 4.30 to 5 P.M.

At Point Pelee Island the wind had been blowing from the east and southeast since noon of the 18th. At about 5 P.M. on the 19th a squall increased its velocity from sixteen to twenty-four miles per hour, and changed, oppositely, its direction from east to west, whence it gradually changed to northwest, to northeast, and back to east. Accompanying the squall was the thunderstorm.

Sandusky, Ohio, experienced the gale and rainstorm without thunder. The wind there attained a velocity of fifty miles an hour.

The observer at Cleveland reported brisk variable winds veering from northwest to east, with storm velocities from 6.55 to 7.25 P.M.

The thermometer had risen to 79.2° *F.* at Port Stanley, Ontario. The direction of the wind from 1 A.M. to noon of the 19th had been east and southeast; from noon to midnight the direction was northeast. During the earlier part of the day the velocity of the wind had ranged from ten to seventeen miles per hour, but in the afternoon the velocity gradually diminished, until at 7 P.M. it was but four miles an hour. After the passage of the thunderstorm, which must have occurred here shortly after 7 P.M., the wind velocity suddenly increased to fifteen miles an hour, dropping back, however, to three miles an hour by 9 P.M. and continuing gentle the rest of the night. The thunderstorm reached Port Dover at 7.30 P.M., and there also caused fresh north and west winds.

The meteorological observer at Erie gives the following report for the day: "Very warm and depressing all day, squally at night. A tidal wave six feet high moved from the northwest at 9 P.M. The wind jumped from seven to twenty-four per hour, was severe, but no damage reported."

The observer at Buffalo says: "Generally fair in daytime, with some threatening conditions in morning, and in the evening rain fell shortly after the 8 o'clock observation, continuing showery during the balance of the evening; warm and sultry, with light variable winds. Distant thunder in the southeast."

At Welland, Ontario, the day was partly clear; the highest temperature was 91° *F.* The thunderstorm occurred there at 8 P.M. Niagara experienced much the same kind of weather as Welland, except that the temperature was somewhat lower and the precipitation not nearly so great.

Ordinary lake waves, as is well known, are due to the action of the wind. The friction of the wind on the surface of the water causes undulations in the water which travel in the same direction as the wind. After the wind which caused the waves

has subsided, the gradually diminishing undulations may continue for some time. These undulations are known as the "swell."

From time to time observers near lakes have noticed movements in their waters which could not be classed as ordinary waves. Any such unusual rise of water is popularly termed a "tidal wave," but in reality the tides in lakes are too slight to be detected by any but the most delicate observations. It is much more probable that such disturbances are caused in one of the following ways:

When a heavy wind blows nearly parallel to the length of a rather narrow lake for a day or so, the waters move with it and rise on the shore against which they are driven. In November, 1892, a storm from the west caused the waters of Lake Erie, near Toledo, to fall eight or nine feet below the normal fair-weather level. At the same time unusually high water was experienced at the eastern end of the lake.

Sudden changes in the outlet of a lake may produce changes in the level of its water; as when an outlet is dammed by an ice gorge or by an avalanche.

Earthquakes produce waves in bodies of water, but there are no instances recorded of such waves in lakes.

A *seiche* is a change of level in the waters of a lake, supposed to be due to changes of barometric pressure on different portions of the water surface. There are also certain rhythmical pulsations, producing a difference of level of three or four inches during calms, when no similar variation of atmospheric pressure can be detected.

The seiche has been quite thoroughly studied in the lakes of Switzerland, particularly by Forel, but although similar movements are known to occur in our great lakes, the subject here is one which awaits investigation.

The rise of the waters of Lake Erie, under consideration, was evidently one of these exceptional movements of large water bodies, and by noting the conditions under which it took place we may be able to gain some knowledge as to their causes.

Was it an earthquake wave?

We can be almost certain that it was not; for if any earth-

quake shock had occurred at that hour of the day, it would have been noticed at some point on the shore, or by some vessel on the lake, which was not the case. Furthermore, an earthquake wave of the size noted would not be local, but probably would be noticed at many, if not all, points on the lake shore.

Was it an example of water piled by the wind?

We can be quite sure that this was not the cause, for on the previous evening there was a calm area near the locality where the rise occurred, away from which the wind blew in three or four different directions. And although, after sunrise on the 19th, the wind kept a generally southeast direction, with an average velocity of nine miles an hour, we may be quite sure that so light a wind, blowing upon a large body of water for so short a time, at right angles to its longer axis, could not have been the cause of the phenomenon.

It may be asked if a difference of barometric pressure might not account for the difference of level of the water.

It is very possible that this may be an indirect cause of the rise, but it is not competent in itself to produce such a change in level. By reference to the barometric conditions for the 19th, it will be seen that there was a "high" area near the central portion of the lake at 8 P.M., where the barometer was 0.08 to 0.09 inches higher than at either end of the lake. As a column of mercury thirty inches high corresponds to a column of water thirty-four feet high, the column of water able to be supported by the pressure in the "high" area would only differ about an inch from the column able to be supported by the pressure at either end of the lake. So the water in the central portion of the lake would only need to fluctuate about half an inch in order to establish its equilibrium.

Was the phenomenon a seiche?

Forel gives as causes of seiches: (*a*) rapid local variation of atmospheric pressure; (*b*) relaxation of the wind which has heaped the lake waters up to one side; (*c*) a gust of wind striking the lake obliquely; (*d*) electrical attraction; (*e*) avalanche winds; (*f*) earthquakes; (*g*) storms.

Some of these causes were incontestably present at the time this phenomenon occurred.

We had a heavy gust of wind striking the lake obliquely as a characteristic result of the thunderstorm. All stations at the western end of the lake reported a gale from the northwest as accompanying the thunderstorm.

Another of the causes which was present was a storm. Whether the storm was the principal cause or not, is difficult to say ; although, by agitating parts of the lake and causing an unstable equilibrium in the atmosphere, it undoubtedly entered in as a cause.

Theoretically, at least, electrical attraction would have some influence upon the action of the water ; but owing to our present incomplete knowledge of the subject we do not know how great the actual effect would be.

In the opinion of the writer the oblique blow given to the water by the northwest wind, and the agitation of water and atmosphere, caused by the storm, were the principal factors causing the result.

This theory seems to be supported by the account of the eyewitness who described the northwest wind following the wave.

There are objections, though, to calling it a seiche. A true seiche is a rhythmic oscillation of the surface of a lake, whereas in this case oscillations seem to have been lacking at some places.

One of the most puzzling circumstances in connection with this phenomenon is the fact that where the wave seems to have struck the shore first, *i.e.*, about five miles west of Erie, where the water is shallow for about four miles out, there were three waves ; while fifteen miles east of Erie, where the water is deeper, there was but one wave. In investigating the cause for this change in the make-up of the wave we should encounter much theory and speculation, which would not be entirely reliable unless we knew all the attending conditions. But we can say one thing with some degree of certainty, *viz.* : if the direction of the waves made an angle of less than 45° with the shore line, the first wave striking the shore would be reflected at such an angle that it will meet and combine with the second wave and form a resultant wave farther along the

shore. This wave, in turn, would be reflected from the shore and reënforce the third wave.

The study of seiches in this country is just beginning to receive attention, and there are some questions about them that we will have to leave unanswered until more definite knowledge is obtained concerning them.

After we have pointed out as many causes as we are able we will probably find ourselves repeating the words of G. H. Darwin, when he writes: "Although it is possible to indicate causes competent to produce seiches, we cannot as yet point out the particular cause for any individual seiche. The complication of causes is so great that this degree of uncertainty will probably never be entirely removed."

ANN ARBOR, MICH.

EDITORIAL COMMENT.

Card Catalogue Summaries. — The last twenty-five years have been noteworthy for the active and successful efforts in organizing the ever-increasing literature of the natural sciences, and the publication of magazines devoted exclusively to the listing of new contributions is now a well-established feature of natural-history work. The advantage of interpolation which the card catalogue system has over the book form of publication is gradually being recognized, and we may now be said to be fairly launched in an experiment for the card cataloguing of all zoölogical literature. The immensity of such an undertaking can be appreciated from the rate at which the card catalogue now issued by the Concilium Bibliographicum at Zurich has grown, and by the largeness of even the more moderate of the proposals in the scheme advanced by the Royal Society of London. One of the difficulties which all these projects meet is that of getting at the substance of a paper for the purposes of classification. Although the rhetorical title is largely a thing of the past, the best contrived title is not always sufficient to indicate the full scope of a paper, and recourse must be made, even for simple bibliographical classification, to the body of the work itself. The growing custom of concluding each paper with a brief summary helps much in this respect, but it is inferior, .in our opinion, to the plan now being pursued by the editor of the *American Journal of Physiology*. This consists in the issuance with each number of the journal of a sheet of index slips for the contributions published in the given number. Each slip is headed by a full bibliographical reference for the paper which it represents, followed by a very brief abstract (not more than 125 words) of the substance of the paper, and so compactly printed that the whole slip can be pasted, if desired, on a card for catalogue arrangement. This plan possesses the great advantage of having the abstracting done by the author himself, and yet under restrictions as to length from the editor, so that a uniform slip is obtained which is perhaps the most serviceable form in which the paper could be presented for classification. Should all journals which publish original scientific matter adopt this plan, we feel sure that the work of the scientific bibliographer would be immensely aided ; nor are we inclined to believe

that the plan would react in any disadvantageous way on the authors. The preparation of restricted abstracts, such as this plan requires, is at least an exercise in concise composition.

The Introduction of Exotic Animals.—The Yearbook of the U. S. Department of Agriculture for 1898 contains a most important and interesting paper by Mr. T. S. Palmer, entitled "The Danger of Introducing Noxious Animals and Birds." Though Mr. Palmer uses animals and mammals as synonymous terms, his subject would bear more extended treatment. The need of legislation to prevent the importation of species which may become injurious is well and temperately stated; scientific men, however, should unite in preserving the integrity of the natural faunas and floras, and should urge that all laws made to forbid the introduction of exotic species include Mongolian pheasants introduced for sport, and skylarks brought here for the charm of their song.

Colors of Deep-Sea Animals. — In a paper of this title (*Rept. Iowa Acad. Sci., 1898*) Dr. C. C. Nutting explains the occurrence of bright pigments and well-developed eyes in animals from great depths by the existence there of a phosphorescent light emanating from the animals themselves, and in support of his idea advances the fact that cave animals, on the other hand, are colorless and blind. We wish to point out that Dr. Walter Faxon in his report on the Stalk-Eyed Crustacea of the *Albatross* expedition (*Mem. Mus. Comp. Zoöl.*, Vol. XVIII, 1895) devotes a special chapter to the colors of deep-sea Crustacea, and suggests the existence at great depths of a phosphorescent light; and he also emphasizes the opposite conditions existing in cave animals. The prevailing red tints of deep-sea forms are explained by Faxon through simple physiological reactions in the chromatophores owing to the absence of bright light, and in support of his theory cites some of the experiments of Pouchet on shore forms.

REVIEWS OF RECENT LITERATURE.

GENERAL BIOLOGY.

Fertility Inherited. — The sixth of Pearson's famous "Mathematical Contributions to the Theory of Evolution," published in the *Transactions of the Royal Society*, has just appeared. It contains three parts, to which Professor Pearson, Alice Lee, and Leslie Bramley-Moore have contributed. The introductory paragraph reads: "I understand by a *factor of evolution* any source of progressive change in the constants — mean values, variabilities, correlations — which suffice to define an organ or character, or the interrelations of a group of organs or characters, at any stage in any form of life. To demonstrate the existence of such a factor we require to show more than the plausibility of its effectiveness; we need that a numerical measure of the changes in the organic constants shall be obtained from actual statistical data."

As a result of numerical studies on fertility and fecundity[1] in man and the thorough-bred race horse, Pearson concludes: Both fertility and fecundity are inherited, and probably in the manner prescribed by Galton's Law of Ancestral Heredity.

Among the other valuable results are methods of finding the coefficient of correlation between brethren and between uncles and nephews, calculating from the means of the "relatives" or "arrays."

The importance of the demonstration of the inheritance of fertility lies in the fact that the most fertile class tends to form a larger and larger percentage of the whole population. Now fertility is correlated with various physical qualities; consequently, these physical qualities are bound to become predominant, if there is no interfering factor at work.

Energy of Living Protoplasm.[2] — In this thoughtful work the famous pupil of Nägeli has carried the science of the chemistry of

[1] *Fertility* is defined as the total number of actual offspring, while *fecundity* is the ratio of this last number to the maximum possible number under the circumstances.

[2] Loew, O. *Die chemische Energie der lebenden Zellen.* München, E. Wolff, 175 pp.

growth and life, of which his master was one of the founders, to a wonderful degree of advancement. The work is a summary of the ideas with which the readers of Loew's numerous papers and his books, entitled *Ein natürliches System der Giftwirkungen* and *The Energy of Living Protoplasm*, have already become familiar.

The theory of Loew starts with the principle that there is a profound difference between living and dead protoplasm. This difference shows itself in the different reactions of living and dead protoplasm; for certain relatively inert substances are fatal poisons, whereas they have no effect on dead protoplasm. The essential living substance must consequently be chemically an extremely unstable, labile substance. This lability depends upon the presence of both aldehyde and amido-groups. Such an extremely labile aldehyde as the theory calls for has been demonstrated to occur in protoplasm. Life depends upon the activities of this labile protoplasm.

The work contains also a theory of albumen formation which has simplicity and completeness in its favor, even though every step has not been experimentally proved. Another valuable chapter is that giving a theory of respiration. Thus, throughout the book the results of biochemistry are used for the interpretation of biological phenomena. It follows that it is a book with which every biologist should make himself acquainted.

C. B. D.

Green Amœbæ. — Dr. A. Gruber, of Freiburg i. Br., has maintained for seven years a small aquarium originally stocked by a bit of dried Sphagnum from the Connecticut valley in Massachusetts. He reports[1] that the fauna, which at first consisted of Rhizopoda, Paramœcium, and Rotifera, is now reduced to a single species of green Amœba and *Paramœcium bursaria*. Both of these forms are found in considerable numbers, being most numerous during the warmer part of the year. Repeated examinations have never as yet detected conjugation stages, nor has any indication of division been observed, though the latter must take place. Both species are abundantly supplied with Zoöchlorellæ, and neither has been observed in recent years to partake of food. Indeed, all food organisms have died off in the aquarium. The Amœba still, after the manner of its forbears, engulfs the shells of Euglypha and Centropyxis, but these are dead and empty. The author infers that by virtue of the commensal Zoöchlorellæ these surviving organisms are living a vegetative life,

[1] Gruber, A. Ueber grüne Amöben, *Ber. Naturf. Ges. zu Freiburg*, Bd. xi (1899), pp. 59–61.

independent of the customary food of the species. When placed in the dark, the green organisms disappear and the death of the Amœba by hunger ensues. Colonies thrive in minute drops of water which would quickly foul were not the Zoöchlorellæ present to renew the supply of oxygen.

C. A. K.

ZOÖLOGY.

The Fossil Bisons of North America. — Mr. Frederic A. Lucas, Curator of the Division of Comparative Anatomy in the U. S. National Museum, has published a most valuable contribution to our knowledge of the Fossil Bisons of North America. His paper,[1] consisting of less than twenty pages of text, is illustrated by twenty half-tone plates, mostly of skulls and horn cores, reproduced from photographs, and representing nearly all of the authentic material of this character relating to the subject. Mr. Lucas has evidently given much time and great care to the preparation of this excellent paper, and has placed the subject, so far as is possible from the scanty material at present extant, on a sound basis. That such a review was much needed is evident, in view of his conclusions.

Seven species are recognized, the distinctive characters of which are based mainly on their horn cores, which he has found afford very good specific characters. The skulls, where available, are found to substantiate the differences shown by the horn cores. The teeth of the various species so closely resemble those of the existing Bison that no attempt has been made to name or identify individual teeth.

The localities from which Bison remains have been reported indicate that the group formerly occurred from Alaska southward to California, Arizona, and Florida; other localities are Idaho, Nebraska, Kansas, Texas, South Carolina, and Kentucky. They range in time from the Pleistocene to the present, and in all probability several of the species were contemporaneous. The seven species recognized by Mr. Lucas, with the localities at which their remains have been found, are as follows:

(1) *Bison bison* (Linn.). Subfossil and recent. Remains in a semi-fossil condition have been found at Big Bone Lick, Kentucky; Millwood, Kansas; loess of the Missouri in the Winnebago Reservation.

[1] The Fossil Bisons of North America, *Proc. U. S. National Museum*, vol. xxi, pp. 755–771, Pls. LXV–LXXXIV, with several text-figures.

(2) *Bison occidentalis* Lucas. Fort Yukon, Alaska, and Gove County, Kansas, in the Quaternary, the Kansas specimen being "a practically complete skeleton." This is a larger species than *B. bison*, with well-marked cranial differences.

(3) *Bison antiquus* Leidy. Big Bone Lick, Kentucky; Alameda County (post-Pliocene gravel) and Pilarcitos Valley, California (blue clay, twenty-one feet below the surface). *Bison californicus* Rhoads (*Proc. Acad. Nat. Sci.*, Phila., 1897, p. 501) was based on California specimens.

(4) *Bison crassicornis* Richardson. Eschscholtz Bay, Alaska. (*B. alaskensis* Rhoads, *loc. cit.*, p. 490).

(5) *Bison alleni* Marsh. Pleistocene, Blue River, near Manhattan, Kansas (type locality), and Snake River, near American Falls, Idaho. *Bison crampianus* Cope, 1894, from southern Kansas, is considered to be the same.

(6) *Bison ferox* Marsh. Pleistocene (?) of Nebraska.

(7) *Bison latifrons* (Harlan). Big Bone Lick, Kentucky (type locality), and Ohio, Texas, Mississippi, South Carolina, Georgia, and Florida. *Bos arizonica* Blake, from Arizona, is referred to this species.

In addition to the above, the following, described as species of Bison, have proved not to belong to this genus, namely, *Bos scaphoceras* Cope, from northern Nicaragua, which proves to be referable to the genus Ovis; and *Bison alticornis* Marsh, based on the horn cores of a Dinosaur (Triceratops), as determined later by Marsh himself.

J. A. A.

"Wild Animals I Have Known."[1] — This book is unique in conception and illustration, and the publishers have given it a daintiness of form quite in keeping with the delicacy of touch that marks its literary and artistic execution. The book is not only as pleasing to the eye as it is out of the ordinary in style of make-up, but is one of the most valuable contributions to animal psychology and biography that has yet appeared. Mr. Thompson is not only a naturalist and an animal artist of very high attainments, but is master of a literary style that is at once graphic and fascinating, though doubtless much of the charm of the book is due to his sympathetic love of the wild

[1] Thompson, Ernest Seton. *Wild Animals I Have Known*, and 200 drawings. Being the Personal Histories of Lobo, Silverspot, Raggylug, Bingo, the Springfield Fox, the Pacing Mustang, Wully, and Redruff. New York, Charles Scribner's Sons, 1898. 8vo, 358 pp., 30 pls.

animals he has come to know so intimately, and whose traits he is thus able to depict so successfully with both pen and brush. To him "animals are creatures with wants and feelings differing in degree only from our own"; this being the case, "they surely have their rights." "Man has nothing that the animals have not at least a vestige of; the animals have nothing that man does not in some degree share." These sentiments are the keynote of the book. His animals are treated as individual personalities, and through this individuality of treatment we get a deeper insight into the life history of the species than if, in the place of "Lobo, the King of Currumpaw," he had given us a long dissertation on the natural history of the wolf, or, in place of "Raggylug, the Story of a Cottontail," he had treated of the life history of cottontails in general.

The eight "stories" in this book treat of: (1) "Lobo, the King of Currumpaw," a famous wolf of the Currumpaw region of northern New Mexico, which for years, as leader of a pack of outlaws, evaded capture, meantime making heavy inroads upon the young calves, colts, and sheep of the ranchmen. His cunning, his heroism, and his pathetic ending are most effectively recounted. (2) "Silverspot, the Story of a Crow," purports to be the individual history of a crow that had his home in the neighborhood of Toronto, and which was distinguishable from other crows by an albinistic spot of white on the side of his head in front of the eye. (3) "Raggylug, the Story of a Cottontail Rabbit." "Raggylug" was distinguishable from his fellows by a slit in one ear. (4) "Bingo, the Story of My Dog," relates to a Collie dog, remarkable for his intelligence, strength, courage, and faithfulness to his master. (5) "The Springfield Fox" is a tale of the intelligence and cunning of a pair of foxes, and of the pathetic love of the mother fox for her unfortunate offspring. (6) "The Pacing Mustang" gives the life of a wild black stallion of the Currumpaw region, renowned for his sagacity and endurance, which ends, like the other stories, in tragedy. "The fact that these stories are true is the reason why all are tragic. The life of a wild animal *always has a tragic end*," says our author, for which statement there is a large amount of evidence. (7) "Wully, the Story of a Yaller Dog," is composite, relating to two mongrels raised as sheepdogs, which were faithful and efficient protectors of their flocks by day, and bloodthirsty, treacherous monsters at night, killing for mere pleasure not only sheep but other dogs, they leading double lives, like many a human monster. (8) "Redruff, the Story of a Don Valley Partridge," is a real character, and his somewhat

idealized career vividly epitomizes the experiences and traits of his tribe. Indeed, the author admits that in some of these stories the characters are pieced together of fragments relating to several individuals, yet no violence is rendered to the general truthfulness of the narration in giving to the incidents the unity of a single individuality.

It is evident that the author of *Wild Animals I Have Known* is a keen woodsman, as well as an accomplished artist and writer, and has given us a book that opens a new field to our vision — a book equally well adapted to young and old, and one which cannot fail to inspire interest in and kindness of feeling toward the beasts that are our kin.

J. A. A.

Ichthyologia Ohiensis.[1] — Dr. Call should have the thanks of American ichthyologists for his transcript of this valuable and very rare work by one of the pioneers of American faunistics. Only eight copies of the original text are known to be in existence. The transcript is from the original articles which appeared in the *Western Review and Miscellaneous Magazine* during the years 1819–21, and afterwards reprinted from the same type in one volume. A biographical sketch of seven and an essay of eleven pages on the ichthyologic work of Rafinesque precede the text of the *Ichthyologia*, which is followed by a bibliography of thirty-three titles and an appendix containing the transcript of an autograph letter with the facsimile of a drawing by Rafinesque of *Pomolobus chrysochloris.* The book is handsomely printed on heavy paper and is limited to 250 numbered copies.

Recent Contributions of Dr. Boulenger to Ichthyology. — Dr. G. A. Boulenger, of the British Museum, has published a third fascicle of materials for the fauna of the Congo, containing descriptions and plates of many new species, chiefly Siluroids. This series is printed at Brussels under the auspices of the Congo Free State, and reflects great credit on the public spirit of that late comer into the assembly of nations. Dr. Boulenger gives in the *Bulletin of the University of Turin* a report on the fishes collected by Dr. Enrico Festa about Panama. The new species are the following: *Piabucina festæ* from

[1] Rafinesque, C. *Ichthyologia Ohiensis;* or, Natural History of the Fishes Inhabiting the River Ohio and its Tributary Streams. A Verbatim et Literatim Reprint of the Original, with a Sketch of the Life, the Ichthyologic Work, and the Ichthyological Bibliography of Rafinesque, by Richard Ellsworth Call, Cleveland. The Burrows Bros. Co., 1899. 175 pp., 8vo, portrait.

Laguna della Pita. *Hippoglossina sabanensis* from Rio Sabana. In this paper Dr. Boulenger seems to have abandoned his respect for the law of priority in nomenclature, to which he has usually shown a proper regard. There is no obvious reason for reverting to Mesoprion, when Lutjanus has priority and the sanction of large current usage. Nor is there any justification for using Pristifoma for Pomadasis. Naturalists must either use the oldest unoccupied generic name, or else abandon all rule and each one do as he pleases. The result of this line of action is the present confusion, from which the rigid application of the law of priority offers the only means of escape.

In the same *Bulletin* Dr. Boulenger continues the discussion of the fishes of Ecuador collected by Dr. Enrico Festa. The species for the most part are identical with those found at Panama. The following new species are described : *Pristifoma labraciforme* from the Bay of Ste. Hélène, Santa Elena, a species close to Poey's *Pomadasis ramosus*, *Hæmulon helenæ* from the Bay of Santa Elena, *Corvina miacanthus* from Guayaquil. This species belongs to the modern genus Bairdiella, *Heros festæ*, from Rio Guayas, Guayaquil.

In the *Annals and Magazine of Natural History* Dr. Boulenger notes the occurrence of *Lepidopus* (or *Benthodesmus*) *atlanticus* at Madeira. The same species has been also recorded from Portugal under the name of *Lepidopus argenteus*. He also discusses the species of the genus Callanthias and describes a new Anabas from the Congo.

Under the auspices of the Department of Agriculture of the Cape of Good Hope, Dr. Boulenger describes two new gobies from the Cape, *Gobius gilchristi* and *Callionymus costatus*.

In the *Proceedings of the Zoölogical Society of London* Dr. Boulenger has a valuable review of the genera and species of Mormyridæ. In this paper stress is laid on the numbers of vertebræ, and these have been counted by means of the Röntgen rays, an interesting application of a discovery in physics to systematic zoölogy. D. S. J.

Teeth of Lizards and Snakes. — The structure and development of the teeth in lizards and snakes have been studied by Dr. H. Levy.[1] The outer enamel layer and the inner dentine layer are clearly distinguishable, and there is no transition in these two layers, as has been claimed for the lower vertebrates. In the development of the

[1] Levy, H. Beiträge zur Kenntnis des Baues und der Entwickelung der Zähne bei den Reptilien, *Jenaische Zeitschrift für Naturwissenschaft*, Bd. xxxii, pp 313–346, Taf. xi.

teeth no superficial germs such as Röse has described in the crocodile were met with, but all germs were, as in the higher vertebrates, deep-seated. In lizards, as in mammals, a dental ridge is formed; this gives rise to a double row of germs, from which the zigzag row of teeth in the adult are produced. The palatine teeth, occasionally found in the lizard, are probably formed from detached germs of this ridge. In snakes the roof of the mouth has on each side two parallel rows of teeth. The origin of these two rows was studied to ascertain whether they came from the same or separate dental ridges. At an early stage the snake possesses a single dental ridge corresponding to the outer row of teeth. Somewhat later two ridges are present, one for the inner and the other for the outer row. From lack of material the author was unable to determine whether both ridges came from the single original one or were formed independently. The dental ridges eventually break up and form small "epithelium nests," from which the germs of the later successional teeth develop. G. H. P.

The Digestive Tract of the Cat. — The morphology of the digestive tract of the cat has been carefully investigated by Dr. Franklin Dexter.[1] Most of the work was done by the dissection of properly hardened embryos, a method much more expeditious and certain than that of reconstruction from sections, but applicable, of course, only to the larger specimens. Dr. Dexter, however, is to be congratulated for having succeeded in dissecting embryos which in the hands of many would have been consigned to the microtome.

At early stages much of the large and small intestine of the cat is contained, not in the body cavity proper, but in the extension of this space into the umbilical cord. This condition has already been observed by Mall in the human subject and in the pig, and has also been identified by Dr. Dexter in the dog and the rabbit. It may be generally characteristic of mammalian embryos. In the cat, part of the liver even may be lodged for a short time in the cord, and the excessive growth of the liver is supposed to be the occasion of this extra-embryonic migration of the intestine. The return of the intestine to the body cavity is accomplished in an orderly sequence: first, a simultaneous entrance of the two extremities of the intestine; secondly, an entrance of the jejunum; and, thirdly, of the remaining portion of the ileum.

[1] Dexter, Franklin. On the Morphology of the Digestive Tract of the Cat. Reprinted from the *Archiv für Anatomie und Physiologie, Anat. Abt.* Boston, 1899.

The differentiation of the colon is also described. After the return of the intestine from its extra-embryonic position, the cæcum, which marks the cephalic end of the colon, lies in the median plane. The cæcum then shifts to the left, and the part of the tube extending from it to the rectum stretches over the course of the descending colon. The growth of the tube in length now carries the cæcum transversely across the body cavity, thus laying out the course of the transverse colon. The tube at last extends caudally on the right side, bringing the cæcum to its adult position and establishing the ascending colon.

The coils of the small intestine were also carefully studied, but no common type of arrangement could be discovered even in embryos of the same litter and of the same size. As the small intestine, hardened in place in five adult cats, showed no common features so far as positions of coils were concerned, it may be assumed that there is no regularity in this respect in the cat.

The paper is concluded with an account of the changes in bulk and form shown by the liver and the probable influences which these have on the disposal of the viscera.

G. H. P.

Regeneration of Arthropod Appendages.[1] — Readers of Bateson's "Materials for the Study of Variation" will recall the experiments made by him and Mr. Brindley on the peculiarities of the regenerated legs of the Blattidæ. Brindley has continued this work and gone over the literature of regeneration in arthropods, and concludes that the regenerated appendage follows one or the other of two types:

(1) In all respects, such as the number of joints and their relative dimensions, the reproduced appendage is the counterpart of the normal congenital appendage.

(2) The reproduced appendage differs from the normal appendage in certain respects which are constant, and in cases where maturity of the animal is attained through a series of ecdyses the special features of the reproduced appendage are perpetuated, so that, strictly speaking, the animal does not reproduce the normal appendage. The chief distinguishing feature of this kind of reproduction is that the number of joints present is *less* than in the normal appendage.

Morphology of the Protobranchia. — An interesting account of the habits, structure, and development of *Yoldia limatula*, *Nucula*

[1] Brindley, H. H. On Certain Characters of Reproduced Appendages in Arthropoda, Particularly in the Blattidæ, *Proc. Zoöl. Soc.*, London, for the year 1898.

delphinodonta, and *N. proxima*, from the coast of Maine, is given by Dr. G. A. Drew.[1] The mantle of Yoldia is supplied with two pairs of sense organs and a fringe of marginal tentacles. There is also an unpaired extensible siphonal tentacle which is protruded upon the surface of the mud in which the animal is buried. Development shows that this is homologous with the marginal tentacles. The foot of all the forms studied serves as a burrowing organ, not as a structure for creeping, as has often been supposed. The palps are active collectors of food, and the gills in Yoldia are very efficient pumping organs. The otocysts are provided with degenerating canals which lead toward the surface, and the genital ducts join the outer, not the inner, ends of the excretory organs. The eggs of *N. delphinodonta* are carried in cases of mucus-like material, while those of the other two species are cast free in the water. The embryos of the first-named species have no locomotor bands, and a feeble apical cluster of cilia, and their development is less rapid. The species of Nucula agree with Yoldia, which has been most fully studied,[2] in the formation of an ectodermal "test" which is afterwards cast off. From this primitive covering the definitive ectoderm, the nervous system, and the stomodæum are formed. The openings of the proctodæum and stomodæum are close together in the region of the primitive blastopore. At the time of metamorphosis the stomodæum, from its primitive opening to the position of the adult mouth, is cast off, together with a part of the apical plate. The test of these protobranchs is held to be the homologue of the velum of the molluscan larva, which has developed from ancestors resembling the embryos of Yoldia and Nucula in form and structure. Chiton, Teredo, Cardium, and Polydordius are known to cast away the velum of the larval stage. The test of the protobranchs is strikingly similar to that found by Pruvot on the embryo of Dondersia one of the primitive group of Solenogastres.

C. A. K.

Innervation of the Pharynx. — The innervation of the laryngeal muscles is an important point in settling their homologies with the muscles of the branchiate vertebrates. The usual statement is that the recurrens nerve supplies all the muscles except the *M. cricothy-*

[1] Drew, G. A. Some Observations on the Habits, Anatomy, and Embryology of Members of the Protobranchia, *Anat. Anz.*, Bd. xv, Nr. 24 (1899), pp. 493–519. With 21 figures.

[2] Drew, G. A. Yoldia limatula, *Mem. Biol. Lab. J. H. Univ.*, vol. iv, No. 3 (1899), 37 pp., 5 pls.

reoideus. Neumayer has recently published the results of his studies.[1] He finds that (1) the recurrens supplies the muscles cricoarytenoideus posticus and lateralis and the thyreoarytenoideus; (2) the recurrens, together with the laryngeus superior, innervate the interarytenoideus transversus and obliquus, the aryepiglotticus and the muscles of the false vocal cord; (3) the cricothyreoideus is supplied by the laryngeus superior.

Holland's Butterfly Book[2] is what its title claims, "a popular guide to a knowledge of the butterflies of North America," and compares very favorably with the numerous books upon butterflies published in England and on the continent. The forty-eight plates are, as a whole, excellent, and will enable an amateur to identify a very large proportion of the butterflies he may collect. The scientific value of the illustrations would have been enhanced if the species figured from the original types had been indicated. The text cannot be regarded as a contribution to science, and the essentially popular character of the work in no way justifies the flippant and egotistical style employed. With "the entire literature relating to the subject" at command, strictly scientific data, such as the distribution of the species, should have been stated more accurately and in greater detail.

The book is sold at a very reasonable price, and it is hôped that its sale will enable Dr. Holland to carry out his intention and issue a similar volume upon the moths of North America. This is even more needed than *The Butterfly Book.*

Embryos of Bdellostoma. — Franz Doflein describes[3] several embryonic stages of Bdellostoma which he obtained at Pacific Grove, California. Before oviposition the eggs lie in a fold of the mesovarium which increases in size and becomes richly vascular and forms a complicated follicle apparatus. The characteristic hooks do not appear until the eggs have reached their full size. They are then formed in pockets of the follicular apparatus, the rest of which forms the horny shell. Only a small per cent of the eggs taken are fertilized, and apparently fertilization takes place outside the mother. The embryo appears on the flat side of the egg, the head being towards the opercular pole. Doflein describes, and his figures show

[1] *Sitzungsber. Gesell. Morph. und Physiol.*, vol. xiv, p. 142, München, 1899.

[2] Holland, W. J. *The Butterfly Book.* A popular guide to a knowledge of the butterflies of North America. New York, Doubleday & McClure Co., 1898. xx + 382 pp., 8vo, 48 colored plates and text-figures.

[3] *Sitzungsber. Gesell. Morph. und Physiol.*, vol. xiv, p. 105, München, 1899.

clearly that the embryo is formed by concrescence. At first the embryo increases in length largely by the formation of new somites, but after about one hundred myotomes appear, growth seems to be more in the increase in size of the somites. Especially noticeable are the large blood sinuses which develop around the embryo. No sections are described in the paper.

The Primitive Pulmonate Kidney. — Meisenheimer points out (*Zeits. wiss. Zool.*, Vol. LXV, 1899) that the apparently distinct types of primitive kidney found in Stylommatophora and Basommatophora can be reduced to a simple tube, closed at its inner end by a differentiated ciliated cell. In the process of differentiation the tube of the Basommatophora retains constantly four cells, while in the Stylommatophora the number is greatly increased. In the Basommatophora one cell becomes greatly enlarged, and in this the process of excretion is concentrated, while no such giant cell is developed in the other group, but excretion is performed by many cells. It is difficult to homologize this system with that found in other molluscs. Meisenheimer points out the similarities of this system to the conditions occurring in the Plathelmenthes, and cites this as an additional proof of the origin of the molluscs from the flat worms.

Life History of the Dicyemids. — As a result of studies of Californian dicyemids, Wheeler concludes (*Zool. Anz.*, Bd. XXII, p. 169, 1899) that the same Dicyema is first nematogen and later rhombogen, and that the so-called infusoriform embryo is, as van Beneden suggested, the male dicyemid. From the relations of the infusorigens and the life history of the animals Wheeler concludes that the male dicyemids arise from fertilized eggs, while the females are produced parthenogenetically. Wheeler points out that this interpretation throws little light upon the systematic position of these forms, since their reproduction is very different from the flat worms. He thinks, therefore, that they should not be an Anhang to the Plathelminthes, while he also thinks they are not worthy of being erected into a subkingdom Mesozoa.

Origin of the Cartilages of the Head. — Lundborg has studied embryos of trout, frog, siredon, and acanthias, and comes to the conclusion (*Morph. Jahrbuch*, Bd. XXVII, p. 242, 1899) that the chondrocranium is of ectodermal origin. He calls attention to the fact that all of the cartilages of the head arise upon the ventral

surface and only later extend to the dorsal side, and would explain this condition by the fact that all of the dorsal ectoderm has been utilized in the formation of nervous tissue. In the same journal (pp. 208 ff.) Dr. H. K. Corning comes to directly the opposite conclusions. His observations were made upon the embryos of the frog, and he bases his opinions upon the negative appearances of the forms studied, and also upon a critical analysis of Miss Platt's papers.

Zoölogical Notes. — In the journal of the Queckett Microscopical Club Mr. D. J. Scourfield has described the winter egg of *Leydigia acanthocercoides*. The proto-ephippium of this rare lynceid is the most highly organized of any yet found in the group and approaches that of the Daphnidæ. The author is engaged upon a study of the epipphia of the Cladocera and desires material for investigation.

The Copepoda of Lincoln, Neb., have been enumerated by Mr. A. D. Brewer in the last number of the journal of the Cincinnati Society of Natural History.

Regeneration in Crustacea has been studied comparatively in many groups by Przibram (*Arb. Zool. Inst.*, Wien, Bd. XI). The author calls attention to the extraordinary resemblance of the regeneration phenomena in organisms to the regeneration of crystals.

Miss Rathbun (*N. A. Fauna*, No. 14) enumerates four species of decapod crustacea from Tres Marias Islands, off the west coast of Mexico.

Miss Harriet Richardson has just published a key to the isopod crustacea of the Pacific coast of the United States (*Proc. U. S. Nat. Mus.*, Vol. XXI, pp. 815–869, 1899). Ninety-seven species are enumerated, including the terrestrial forms.

North-American entomology has had no keener observer or more careful and conscientious recorder than the late Henry G. Hubbard. Since his death Mr. E. A. Schwarz has printed two series of Mr. Hubbard's most interesting letters ; one, in *Entomological News* for April, describes the home of *Dinapate wrightii;* and a second, in *Psyche* for May, gives an account of the insect fauna of the giant cactus of Arizona.

No. 4 of Vol. XXV of the *Transactions of the American Entomological Society* concludes with Fox's study of the North-American Mutillidæ. The high character maintained by this society in all of its publications is well illustrated in this most admirable paper.

It so rarely happens that a second edition of a systematic paper on insects is called for, that it may be well to note the issuance, as a special bulletin of the Hatch experiment station of the Massachusetts Agricultural College, of a revised edition of Professor Fernald's Pterophoridæ of North America (cf. *Amer. Nat.*, August, 1898, Vol. XXXII, pp. 596, 597). Five new species are characterized, but the date of publication, July 30, 1898, unfortunately precludes the consideration of the suggestions and corrections made by Lord Walsingham in the *Entomologist's Monthly Magazine* for August and September, 1898.

The position of Yoldia and Nucula as among the most primitive lamellibranchs lends especial interest to Dr. Gilman Drew's recent summary of the known features of the anatomy and embryology of American representatives of these genera (*Anat. Anzeiger*, Bd. XIV, p. 493, 1899).

The ampullæ of Lorenzini in the selachians are described by Forsell (*Zeit. wiss. Zool.*, Bd. LXV, 1899), who, however, does not add much to our knowledge of the function of these problematical organs.

The periods of sexual maturity of the animals of the Gulf of Naples are enumerated by Dr. Salvatore Lo Bianco in the last Heft of Bd. XIII of the Naples *Mittheilungen*. The list occupies about 125 pages. We have already called attention to similar work carried on by Professor Bumpus at Woods Holl.

The urogenital organs of the turtles are described from the anatomical standpoint by Möller (*Zeit. wiss. Zool.*, Bd. LXV, 1899).

Ravn points out (*Anat. Anz.*, Bd. XV, p. 528, 1899) that the septum transversum of the vertebrates is developed by the union of the mesocardia lateralia, which meet in the middle line. Those interested in this subject and the closely allied one of the origin of the diaphragm of the mammals must consult the recent article by Hochstetter upon the formation of partitions in the body cavity of the saurians (*Morph. Jahrbuch*, Bd. XXVII, p. 263, 1899).

A new edition of van Gehuchten's admirable text-book, *Le système nerveux de l'homme*, is announced for the end of the current year.

The Australian Bower-Birds, their nests, eggs, and playgrounds, are described and illustrated by photographic reproductions in the *Proceedings of the Edinburgh Royal Physical Society* for 1897–98.

BOTANY.

The New York Botanical Garden. — The recently issued fourth *Bulletin of the New York Botanical Garden*[1] carries the first volume of that publication to page 294 and Plate VIII. In addition to administrative reports for the year 1898, the present number contains the following botanical contributions: Britton, "Description of a New Stonecrop [*Sedum Mexicanum*] from Mexico"; Rydberg, "The Cespitose Willows of Arctic America and the Rocky Mountains"; Small, "Undescribed Plants of the Southern United States"; and Nash, "New Grasses from the Southern United States."

The Chelsea Botanical Garden. — According to *Natural Science* for May this garden, which was founded about 1673 by the Apothecaries' Company, and has of late proved a greater burden to the society than they wished to carry, has been turned over to the trustees of the London Parochial Charities, who undertake to provide £800 annually for its maintenance. It is a matter for congratulation that this historic establishment has thus been saved.

Corn Plants. — In an attractively gotten up little volume[2] Mr. Sargent presents for young people some of the important facts concerning the cereals used for breadstuffs.

Botanical Notes. — Dr. Boerlage has begun the publication of a quarto catalogue of the phanerogams (with the exception of herbs) cultivated in the great garden at Buitenzorg, Java. The first fascicle, of 59 pages, contains the orders from Ranunculaceæ to Polygalaceæ, inclusive.

A revision of the genus Listera is published by Karl M. Wiegand in the *Bulletin of the Torrey Botanical Club* for April.

Nos. 4 and 5 of the current volume of the *Memoirs of the Boston Society of Natural History* are partly botanical and consist, respectively, of papers on "Localized Stages in Development in Plants and Animals," by R. T. Jackson, and "The Development, Structure, and Affinities of the Genus Equisetum," by E. C. Jeffrey.

[1] *Bulletin of the New York Botanical Garden*, vol. i, No. 4. Issued April 13, 1899. 8vo.

[2] Sargent, F. L. *Corn Plants, their Uses and Ways of Life.* Boston and New York, Houghton, Mifflin & Co. 32 f., ix + 106 pp.

With Lieferung No. 184–5, Parts II–V of *Engler und Prantl's Natürlichen Pflanzenfamilien* are brought to an end, so that the treatment of the phanerogams is now finished, with a complete index to popular names, etc., and to the Latin names of genera and species mentioned.

The New England Botanical Club announces in *Rhodora* for May its intention to publish a check list of New England plants, indicating the presence or absence of each admitted species or variety for each of the six New England States.

Quercus ellipsoidalis is the name applied by E. J. Hill in the *Botanical Gazette* for March to a black oak found in the vicinity of Chicago, which possesses a blending of the characters of *Q. coccinea, velutina*, and *palustris.*

The dissemination of Arceuthobium, or, as it is now sometimes called, Razoumofskya, is the subject of an interesting paper by MacDougal, in a recent number of *Minnesota Botanical Studies.*

The Columbine Association has secured an admirable presentation of the claims of the beautiful flower whose name it bears to recognition as our national flower in an address on "The National Flower Movement," by the president of the association, Mr. F. L. Sargent, delivered before the Massachusetts Horticultural Society in February, 1898, and printed in the recently issued first part of the *Transactions* of the society for 1898.

The phylogeny of Ulmaceæ is discussed by Houlbert in an illustrated article published in No. 123 of the *Revue Générale de Botanique.* A comparative study of the arrangement of the wood elements during the maturation of the trunk (which does not reach its characteristic development until about the tenth year) shows that the structure passes successively through stages comparable with those characteristic of the Boehmerias, Planera, Sponia, and Morus.

A new limnoplankton form, reported by Zacharias (*Biol. Centralb.*, Vol. XIX, No. 9, p. 285) as common in the smaller lakes of Holstein, has recently been identified by the fungologist Ludwig as a modified form of the musk fungus, *Cucurbitaria aquæductum*, which is common in water pipes and on water wheels.

GEOLOGY.

The Physiography and Geology of the Nicaragua Canal Route were studied by Dr. C. Willard Hayes, of the United States Geological Survey, during ten months' field work in 1898, in connection with the surveys made by the Nicaragua Canal Commission, of which Admiral J. B. Walker is president. The more general results of these studies have recently been published in a concise form and should be of interest to naturalists as well as to geographers and geologists.[1] The summary of the conclusions reached, as published by Dr. Hayes at the close of his admirable paper, is as follows:

"The region discussed embraces the belt of country extending from the Caribbean Sea to the Pacific in northern Costa Rica and southern Nicaragua, adjacent to the route of the proposed Nicaragua canal.

"Its most important physiographic feature is the broad depression which extends diagonally across the isthmus, between the recent volcanic ranges on the southwest and the Chontales hills on the northeast. The topography of this depression is chiefly that of an old land, generally reduced to the condition of a peneplain by streams flowing in opposite directions from a former divide near the axis of the isthmus.

"The rainfall on the Caribbean side of the isthmus is very abundant and distributed uniformly throughout the year. On the Pacific side it is less abundant and confined to half the year. This climatic difference produces striking differences in vegetation, rock decay, rate of erosion, and resulting topographic forms.

"The rocks of the region are largely volcanic products, with two sedimentary formations of Tertiary (Oligocene) age, and no rocks occur which are certainly older than the Tertiary. The igneous rocks are in part contemporaneous with the Tertiary sedimentary formations and in part recent.

"On the east side high temperature with abundant moisture and consequent rank and rapidly decaying vegetation afford exceptionally favorable conditions for rock decay, which has extended to great depths and yields red clay as the final product. On the west side alternate wet and dry seasons afford less favorable conditions for rock decay, and the final product is blue clay.

[1] Hayes, C. Willard. Physiography and Geology of Region Adjacent to the Nicaragua Canal Route, *Bull. Geol. Soc. Amer.*, vol. x (1899), pp. 285–348, Pls. XXX–XXXII.

"In early Tertiary (Oligocene) time there was probably free communication across this portion of the isthmus between the Atlantic and the Pacific. A great mass of sediments was deposited in a shallow sea, and many volcanoes were in active eruption.

"In middle Tertiary time the region was elevated and subjected to long-continued subaërial degradation, and the narrower portion of the isthmus was reduced to a peneplain, with monadnocks at the divide near the axis. There is no evidence that open communication has existed between the two oceans across this portion of the isthmus since the middle Tertiary uplift.

"In post-Tertiary time the region was again elevated, and the previously developed peneplain deeply trenched.

"A recent slight subsidence has drowned the lower courses of the river valleys, and the estuaries thus formed have subsequently been filled with alluvial deposits.

"Recent volcanic eruptions have formed a barrier across the outlet of a bay which formerly indented the Pacific coast. The waters rose behind this barrier until they reached the level of a low gap in the continental divide, when they discharged to the eastward and the divide was shifted to the newly formed land near the Pacific coast. Lakes Managua and Nicaragua thus occupy the bed of the former bay and the basins of rivers which were tributary to it."

Accompanying the paper is a map of the region adjacent to the canal route, showing the positions of active and extinct volcanoes, present and former continental divide, former Pacific coast line, proposed canal route, etc.; and a sheet of geological sections.

ISRAEL C. RUSSELL.

NEWS.

PROFESSOR C. J. HERRICK, of Denison University, has been awarded the Cartwright prize of $500, by Columbia University, for his work upon the brain of fishes.

One feature of the work of the veterinary congress, held in Baden August 9–14, is an attempt to provide a uniform anatomical nomenclature.

For the present, at least, the collections of the Museum of Practical Geology, in Jermyn Street, London, will not be merged with those of the Natural History Department of the British Museum.

Some of the botanists propose to make one day of the meeting of the American Association for the Advancement of Science at Columbus a memorial day in honor of Sullivant and Lesquereux, who lived for many years in that city.

Dr. D. G. Brinton has presented his valuable library, relating to American linguistics, to the University of Pennsylvania.

Columbia University has recently received the conchological collections of the late Henry D. Van Nostrand.

Professor L. V. Pirsson, of Yale University, succeeds the late Professor Marsh as an editor of the *American Journal of Science and Arts.*

It now seems probable that $20,000 will be raised for Mr. J. E. S. Moore's expedition to investigate Lake Tanganyika.

The legislature of Arkansas has made provision for the publication of the remaining reports of Dr. J. C. Branner, for several years state geologist. These reports are largely economic in character and deal with the coal, clays, bauxite, kaolin, zinc, and lead deposits. Some of the earlier reports are out of print, and these will be reprinted.

The state of Wisconsin has appropriated $10,000 for two years for a geological and natural history survey of the state. Professor E. A. Birge, of the state university, is the director of the survey.

The corner stone of a museum of oceanography, founded by the Prince of Monaco, was laid on April 26. Representatives of the

French and German governments were present. The museum is intended to contain the collections of the yacht *Princess Alice*, which for several years has been engaged in the study of the fauna of the deep seas.

Columbia University has recently received $10,000, to be known as the Dyckman Fund, the interest of which will be used in the encouragement of biological research on the part of graduate students.

Mr. J. Dörfler, Barichgasse 36, Wien, III, Austria, is preparing a new edition of his directory of botanists, which will be issued about the first of next year.

A school of geography is about to be established in the University of Oxford through the coöperation of the university and the Royal Geographical Society, each institution to bear half of the expense. It will be under the direction of Mr. H. J. Mackinder, who has held the position of reader in geography for the past twelve years.

Mr. F. V. Bennett has resigned from the Geological Survey of the United Kingdom after a service of over thirty years.

Dr. Adolf Fich, professor of physiology in the University of Würzburg, has resigned on account of age.

The *Naturalists' Directory* will be reëdited for 1899 by S. E. Cassino.

Appointments: Dr. A. P. Anderson, assistant professor of botany in the University of Minnesota. — Dr. Wilhelm Benecke, of Strassburg, docent for botany in the University of Kiel. — Dr. Alfred Bergeat, of Munich, professor of mineralogy and geology in the mining academy at Clausthal. — Dr. Franz Boas, professor of anthropology in Columbia University. —Professor Alessandro Coggi, of Perugia, professor of zoölogy and comparative anatomy in the University of Sienna. — Dr. Nikolaus Karl Czermak, professor of anatomy, histology, and embryology in the University of Dorpat. — Dr. von Elterlein, docent for mineralogy and geology in the University of Erlangen. — Dr. Enrico Festa, assistant in the zoölogical museum of the University of Turin. — Dr. Alberto Fucini, docent for paleontology and geology in the University of Pisa. — Dr. Ercole Giacomini, of Sienna, associate-professor of zoölogy and comparative anatomy in the University of Perugia. — Dr. Hugo Glück, docent for botany in the University of Heidelberg. — Dr. J. M. Janse, director of the botanical gardens at Leiden. — Dr. Max Koch, of Berlin, titular professor of geology. — Dr. A. C. Lane, state geologist of Michigan. — Dr. G. Lindau, custos of the Royal Botanical Museum in Berlin. — Albert

Lindström, prosector in the Karolinian Institute in Stockholm, honorary professor. — Dr. Günther Beck von Mannagetta, of Vienna, professor of systematic botany in the German University of Prag. — A. J. Pieters, first assistant in botany in the Department of Agriculture at Washington. — Dr. Antonio Porta, assistant in the zoölogical museum of the University of Parma. — Dr. Ótto Stapf, chief assistant in the Kew herbarium. — Dr. Weinschenck, docent for mineralogy and geology in the Munich Technical School. — Dr. Karl Wenle, of Berlin, directorial assistant in the Ethnological Museum in Leipzig.

Deaths: Otto Böckeler, botanist, at Vavel, Oldenburg, March 5, aged 96. — Charles Brogniart, assistant in entomology in the Paris Museum of Natural History, aged 40. — Thomas A. Bruhin, botanist, in Basel. — Abbe Francisco Castracane, student of diatoms at Rome, aged 82. — Dr. A. W. Chapman, well known for his former studies of the flora of the southern states, at Apalachicola, Fla., April 6, in his ninetieth year. — Johann Dorfinger, student of lepidoptera in Vienna, March 19, aged 86. — Joseph J. Dowling, ornithologist, at Dublin, February 2. — Otto Gelert, botanist, at Copenhagen, March 20. — Dr. Gremley, a botanist, at Egelshofen. — Sylvanus Hanley, conchologist. — Franz Ritter von Hauer, a well-known geologist and former director of the Austrian geological survey in Vienna, March 20, aged 77. — Dr. Theodor von Hessling, formerly professor of anatomy in the University of Munich, aged 83. — Dr. H. B. Herretson, an English oculist and ornithologist, aged 49. — James Hogg, well known to the older generation of microscopists, in London, April 23, aged 82. — John Lee, an English botanist, January 20, aged 49. — Sir Frederick McCoy, professor of natural science in the University of Melbourne, well known for his geological investigations, aged 76. He was a native of Dublin, but had lived in Australia since 1854. — Dr. F. Minà Palumbo, a Sicilian zoölogist, March 12, aged 85. — Dr. Rijke, professor of natural history at Leiden, aged 85. — Edward W. Roper, conchologist, in San Diego, Cal., December 31, aged 40. — Rev. Alfred Charles Smith, ornithologist, in Devizes, England. December 7. — Joseph Stevens, of Reading, England, archæologist and geologist, April 7, aged 81. — G. C. Swallow, for several years state geologist of Missouri, April 20, aged 82. — Dr. C. C. Wallich, of the British Army, aged 83. — J. H. Wifbe, of Schenectady, N. Y., botanist, aged 60. — Franz Woenig, botanist, at Leipzig. — Mr. Joseph Wolf, the artist whose illustrations of zoölogical works are familiar to all.

CORRESPONDENCE.

THE NEEDS OF AMERICAN ANTHROPOLOGISTS.

There are a few things which American anthropologists are much in need of. Anthropology is making steady progress in this country, as can be seen in the increase of workers in the science; in the amount and quality of their publications; in the number of universities and colleges, which include some part of the science in their curricula; and, finally, in the growing public interest in anthropology. Among the most recent important advantages to the science may be mentioned the establishment of a larger efficient journal, the *American Anthropologist*. At about the same time the *American Naturalist* decided to devote regularly to anthropology a part equal to that given to any of the older sciences. Section H of the American Association for the Advancement of Science has held, since 1897, two meetings a year, and both the meetings of last year met with large success. The Washington Anthropological Society has been recently strengthened by joining an allied body; while in New York there have been held the last season, under the auspices of the Academy of Sciences, successful monthly anthropological meetings. Regular courses or lectures in anthropology are given in the Columbia, Harvard, and other universities. The University of Iowa has recently organized a comprehensive anthropologic course; and there are many lectures on ethnology or archæology delivered more or less irregularly in New York, Washington, Brooklyn, Chicago, Boston, and, I believe, in San Francisco. Besides all this, much work is being actually done in the field. I need mention only the Jessup expeditions under Dr. Boas to the northwestern coast and into Asia, by the American Museum of Natural History; the expeditions southwest into the Pueblo region, by Messrs. Fewkes and Pepper; the expeditions into Mexico, by Messrs. Saville, Lumholz, Starr, and Holmes; the work which is being done in Ohio, by Mr. Moorehead and others; and the tireless efforts in the Trenton gravels and elsewhere, under the direction of Professor Fred. W. Putman. In fact, this list would have to be much prolonged in order to do justice to all the men who are or have been recently active in important field work.

All this shows beyond a doubt that the American anthropologists are active and progressing. When any science in a given country arrives at such a stage of activity as here outlined, there arise certain wants which, if attended to, make further progress more definite, systematic, and easier. Under such circumstances it is fortunate if there are established in other countries well-tried precedents which fulfill similar wants of the same science. We have such precedents in anthropology. We find them particularly in France, but also in England, Germany, and Italy. There are many good examples to follow in supplying our needs, and there are also some occurrences which ought to serve as a warning.

The one need of American anthropologists which I consider important above everything else is the establishment of an *Anthropological Institute.* There is needed a common independent center, such as the French anthropologists have in their Institute of Broca, the English in the Institute of Great Britain and Ireland. The French example is much the better, the English center being a little more than a clubhouse. Broca's Institute is a great depository of anthropologic material, which otherwise would be scattered or lost; it is a laboratory in the full sense of the word; it is a great school for students in anthropology, who come there from all countries; its lectures are free to the public; it possesses a large and very valuable anthropologic library, and almost a complete collection of anthropologic instruments, and both the books and instruments stand there for ready reference or use; finally, the Institute is the center of French anthropologists, to which are presented their best efforts, in which are held their sessions, and in which originate the most powerful impulses for further work.

The moral and practical influence of such an establishment on the science for which it stands cannot be measured. Can any one estimate how much good such an Institute could be to the American anthropologists of to-day and of the future? The American anthropologist has a great deal of difficult work before him. He is confronted with problems which are not equaled in number or importance by those of any other country. The problems do not concern the United States alone, but the whole extent of both Americas, and they are so complicated, large, and numerous, that they will require the best scientific talent and attention for generations to come. Nothing could more facilitate the solution of these problems than a first-class anthropological Institute.

As immigration progresses and various countries on this continent,

and especially in South America, become peopled, anthropology will be taken up in different places beyond the United States. By that time the United States ought to be to America in anthropology what France has been and still is to Europe. But this it cannot be without one or rather a number of first-class Institutes, which would offer everything to the foreign student which he will not be able to find at home.

It is very plain why the United States, more than any other country on this continent, should become the leader in anthropology. No other American country possesses such resources and, perhaps it might be added with justice, none such an abundance of apt and, particularly, energetic workers.

How would the establishment of an anthropological Institute be practicable? Paris gave as a place for the Broca's Institute a part of one of its public buildings, and the French government supports the establishment. Similar things might be done here, were a few influential citizens and officers of some large scientific center, or of some state, interested in the proposition. Possibly the government of the United States itself would support the project. The aid of the government would of all be the most desirable, and with it the execution of the project the most feasible. The government supports the American Bureau of Ethnology, besides other allied institutions. Perhaps the scope of the Bureau of Ethnology, which is doing excellent anthropological work, could be enlarged, until the bureau would comprise all classes of anthropological work and at the same time develop into a center of instruction in the science. In such a case there ought to be at least two branch Institutes, one in New York and one in Chicago. In case of the failure of government or state or city support, there still exists the possibility of securing the interest of one or more wealthy private persons. But all these are mere theories, and it is not my object to advocate any of them specifically. My sole aim is to arouse interest among American anthropologists in this proposition, and if I succeed in this, the practical way of effecting the project will surely be found later.

There are other things which American anthropologists, particularly those who occupy themselves more with somatological investigation, need besides an Institute, and the most important of these are a *uniform, definite nomenclature* and a *uniform system of measurements.* There are practically two systems of anthropological nomenclature, as well as of measurements, in existence; namely, the French and the German. The result of this is much confusion. It is difficult

to see why the clear, concise system of measuring, and the terms which were used by the French and English anthropologists, were modified by the Germans. The change resulted in great loss of work, especially on the German side; but this is no occasion for any critical dissertation on this subject. The fact is that there are two different systems of nomenclature and measurements, and that the American anthropologists must choose *one* of these systems in order to avoid much confusion and loss of work on their side. Furthermore, there are terms used somewhat vaguely by both the European schools and a few new terms, the meaning of all of which should soon be made as definite as possible. It might be well not to do anything in nomenclature unless it is in accord with at least the majority of European anthropologists. Section H of the American Anthropological Association of Science is the best body in which steps leading to a standard American anthropological nomenclature and measurements should be taken. Something to this effect has already been done in the section. But this society should not act, except in concord with the English and French anthropological branches of the Associations for the Advancement of Science and with the Berlin anthropologische Gesellschaft.

A few words about new terms. The coining of many new terms in anthropology is decidedly injurious and meets with much antipathy, unless the new terms were really needed and designate really new things or conceptions.

In addition to the above I should like to call the attention of the American anthropologists to a few things which would prove of advantage.

In the first place, the American student of anthropology would be exceedingly grateful to his masters, would they present him with a concise but complete history of the science in this country. It is only recently that the American Medico-Psychological Association appointed a committee for the purpose of collecting materials for and writing the history of Psychiatry in this country. Perhaps we could follow their most commendable example and do as much in our section in the American Association for the Advancement of Science.

Besides lacking the history of the science, the student of anthropology in this country is much in need of reliable translations and cheap editions of American anthropological classics. There are many very valuable works of this sort in Spanish and other foreign languages, and even in English, that are accessible to but very few. We need something like the medical publications of the Sydenham Society.

So far as practical anthropological work is concerned, it is very advisable that early efforts should be extended to obtain permission for free exploration in Mexico and other American republics. There are great gaps in our knowledge and collections of these regions, and efforts to fill these meet with more and more difficulty, especially in Mexico, on account of the restrictions imposed upon explorations. These restrictions would be excusable if they would lead to the securing of the very valuable archæological and ethnological material found in the countries where these rules have been made, but such is far from being the case. The countries which are richest in various remains do very little to preserve these remains. In the mean time valuable things are being constantly destroyed by ignorant people. The anthropologists of the United States should not allow these matters to go on, but make a determined effort to have the restrictions to explorations recalled. At this very moment one of the Mexican custom houses holds a valuable and largely unique, though fortunately not large, American collection. The collection consists of petroglyphs which were obtained at great pains from the deep Sierras, where they were going to a speedy ruin. They are held on the supposition that they are parts of "some Aztec temple."

In the last place, it seems to me to be to our best interest to prevent as far as possible the exportation of other than duplicate specimens of American aboriginal art into Europe. Many collections that go to Europe, particularly to Germany and France, could be bought here. This would save the American student the necessity of consulting, in his investigations concerning his own or near countries, European publications and museums.

A. Hrdlicka.

New York.

PUBLICATIONS RECEIVED.

(The regular Exchanges of the *American Naturalist* are not included.)

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THE AMERICAN NATURALIST

A MONTHLY JOURNAL
DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE

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A CONTRIBUTION TO THE LIFE HISTORY OF AUTODAX LUGUBRIS HALLOW., A CALIFORNIAN SALAMANDER.

WM. E. RITTER AND LOYE MILLER.

Autodax is a genus of salamanders confined, according to our present knowledge, to western North America and almost entirely to California. Three species are known, namely, *A. lugubris* Hallow., *A. ferreus* Cope, and *A. iëcanus* Cope. The genus belongs to the Plethodontidæ and is undoubtedly close of kin to Plethodon itself. *A. lugubris*, the most common and best known of the species, is, however, according to Cope (**'89**), "one of the most marked species of North American salamanders," and it is an interesting and suggestive fact that all the zoölogists who have written concerning members of the genus have noted about them various reptilian characteristics either of structure or habit. Thus, Spencer Baird (**'52**), one of the earliest observers of *A. lugubris*, the subject of the present paper, mentions the unusual size of the teeth and compares the undulating outline of the mouth to the mouth of the alligator; and Charles Girard (**'58**) makes the same comparison. Cope (**'89**) points out these reptilian assimilations in the following

words, his remarks having reference to *Autodax lugubris:* "This is one of the most marked species of North American salamanders. The large temporal muscles give the head a swollen outline behind and separate the derma from the cranium. The latter adheres to the top of the prominent muzzle. The fissure of the mouth is sinuate, most strongly so in adult specimens. On the whole, the physiognomy is not unlike that of the snapping tortoise. I have little doubt that it is more capable of inflicting a bite than any other of the American Urodela."

Dr. John Van Denburgh ('**95**), who has had much more opportunity than any of the preceding writers to observe Autodax alive, makes these statements about the habits of *A. iëcanus:* "It usually walks quite slowly, moving but one foot at a time, but it is capable of motion surprisingly rapid for a salamander. When moving rapidly, it aids the action of its legs by a sinuous movement of its whole body and tail.

"The tail of this Autodax is prehensile. Several individuals, when held with their heads down, coiled their tails around my finger, and, when the original hold was released, sustained themselves for some time by this means alone. One even raised itself high enough to secure a foothold. This animal's tail is also of use to it in another way. When caught, *Autodax iëcanus* will often remain motionless, but if touched will either run a short distance with great speed, or, quickly raising its tail and striking it forcibly against the surface on which it rests, and accompanying this with a quick motion of its hind limbs, will jump from four to six inches, rising as high as two or three."

Most of these observations by Van Denburgh we have many times confirmed in our experience with *A. lugubris,* although we have never seen it jump on a level, nor to so great a distance as that mentioned by this writer. When wishing to pass from an elevated position to a lower level, as, for example, from the hand to the table when the former is held some inches above the latter, instead of falling over the edge in the typical salamander fashion, the creature will frequently execute a well-coördinated spring and alight on its feet some distance away.

The quickness of movement of Autodax, as contrasted with the general sluggishness of the typical salamander, is striking indeed.

Although the illustrations given by Cope ('89), p. 184, show fairly well the characteristics of the head mentioned by him, in several respects these are really more marked in fully grown specimens than his figures indicate. We have, consequently, thought it best to supplement his illustrations. Figs. 1 and 2 are dorsal and lateral views of the head of a large male.

FIG. 1.

The teeth of the projecting upper jaw in adults are distinctly visible when the mouth is closed, their points not being covered by the lip (Fig. 2). Further, their large size causes ridges on the outer surface of the lip. Professor Cope's conjecture that the animal is capable of inflicting a bite is certainly very reasonable, but we have been unable to get any positive evidence on the point.

The species is entirely terrestrial and seems to be indifferent even to a proximity to water. Rotten stumps and logs are the preferred habitations, and wherever these occur in the region about San Francisco Bay, even though at the remotest places from water, specimens are almost sure to be found, and frequently in considerable numbers in or under the same stump. Thus a single stump at Sausalito, Marin County, yielded to one of us seven specimens of one size and five of another size, none of them, however, being fully grown. Those of the smaller size were about 50 mm. long, and were dark gray, almost black, in ground color, with finely sprinkled bluish silver. Those of the large size were about 75 mm. long, were much lighter in ground color, and were wholly devoid of the silvery specking, but possessed a few relatively large yellow spots

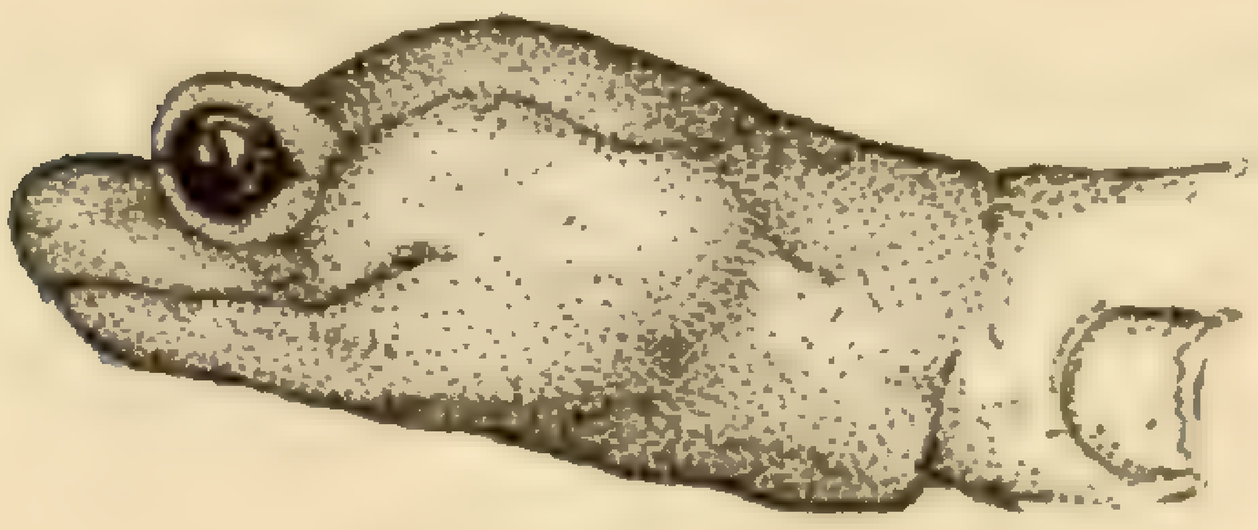

FIG. 2.

on the sides of the abdomen. As we now know, the smaller darker ones were of last year's hatching; and in all probability the larger ones were a year older. The presence together of so many individuals suggests that those of the same size all belonged to the same brood; and also the possibility that the two broods represented were both the offspring of the same parent. Of course there was no way of answering this query positively, but one other piece of information that we have obtained confirms the suggestion in so far as it furnishes farther evidence that the young of a brood may remain together for a considerable period after hatching. Some time during March, 1896, a student in zoölogy, whose testimony we regard as reliable, reported to one of us that he had found a fully grown salamander, which, from his description, was undoubtedly Autodax, "with a lot of little ones."

The species is decidedly nocturnal in its habits. This is not only proven by the fact that one practically never finds it abroad during the daytime in nature; but also by the alacrity with which specimens kept in confinement in a terrarium seek to secrete themselves during the daytime, but come out and run about freely during the night.

As shown by Wilder, Autodax is, in common with so many of the long-tailed amphibians, lungless. This being so, the exclusively terrestrial habit of the animal makes the question of the seat of respiration in this species particularly interesting.

We do not propose to go at length into a discussion of this subject at present, but content ourselves with noting a few observations that support the view recently defended with special emphasis from the morphological side by Bethge (**'98**), that, in the absence of both gills and lungs, respiration is performed by the mouth epithelium and the integument together, each taking an essential part. This is in opposition to the conclusion drawn by Camarano (**'94**), in particular, from physiological studies on *Salamandrina perspicillata* and *Spelerpes fuscus*, both lungless salamanders. This author believes that the skin participates very little, if at all, in respiration.

The facts which we interpret as meaning that the integument takes an important part in respiration are these: In the

first place, the softness, delicacy, and constantly moist condition of the skin of the entire body, and the abundant supply of blood vessels and capillaries within it, furnish the structural conditions necessary for respiration. In this connection the vascular supply to the toes deserves particular attention.

A great blood sinus is present on each side, and near the end of each of these organs (Fig. 3).

These lakes of blood, as they may be called, become particularly conspicuous in animals that have been anæsthetized with ether or chloroform, though they are easily seen by the aid of a hand lens in the normal living specimens. It is a reasonable supposition that we have here a not unimportant seat of respiration. No portion of the integument is better

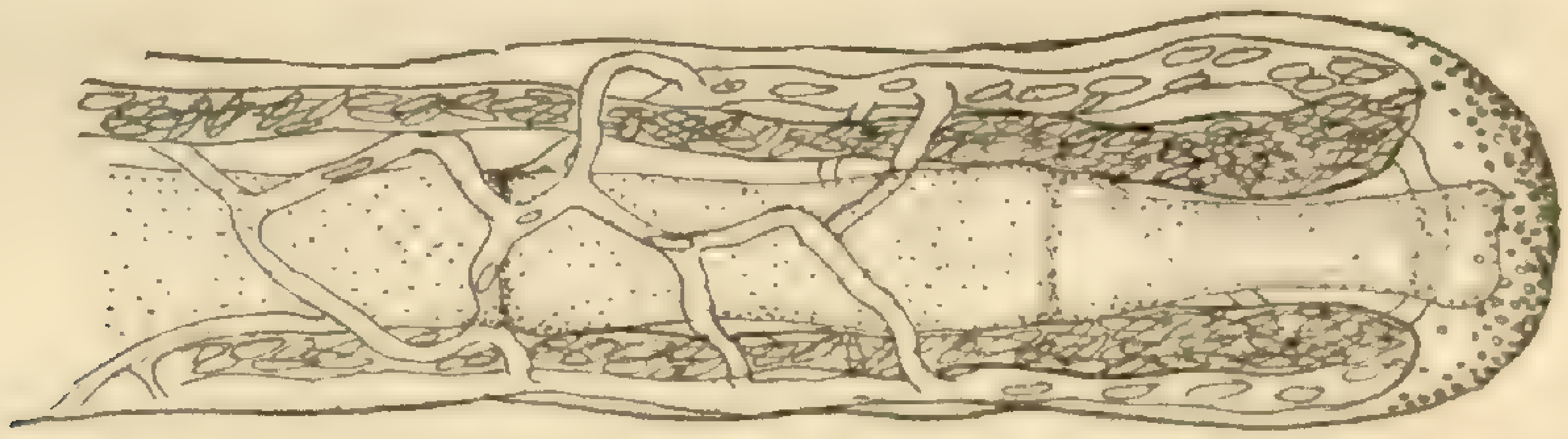

Fig. 3.

calculated to make the most of what little moisture there may be in the animal's surroundings, they being especially adapted to this end both as regards contact with moist bodies and area of surface exposed. The toes, in fact, may be considered to have assumed in a measure the function of external gills.

How generally this vascular condition of the toes is among the amphibia we do not know. In two other species having much the same habits, at least as regards dwelling places, which we have examined, namely: *Plethodon oregonensis* and *Batrachoseps attenuatus*, practically the same conditions are found, while in *Diemyctylus torosus*, the habits of which are quite different, and in which lungs are present, no unusual degree of vascularity is found in the members.

The toe-tips of Autodax are somewhat expanded (Fig. 3), and the animal has considerable power of clinging by means of them to vertical and overhanging surfaces. In this respect it resembles Hyla somewhat, and consequently a comparison between the two forms with respect to toe structure is suggested.

Examination of the toes of living specimens of Hyla reveals the fact that here also the tips — pads, as they are well known to be in this animal — are rather richer in capillaries than are other portions of the feet and limbs, but the blood sinuses are not present. Schuberg (**'91**) has made a detailed study of the toes of the *Hyla arborea*, and although he does not particularly discuss the blood supply to the organs, his figures show not only that the sinuses are absent here, but they seem to indicate that blood vessels and capillaries are not especially abundant.

That the pharynx also plays an important part in respiration is indicated by the constant vibration of the region. From 120 to 180, or even more, of these vibrations take place in a minute, and in some cases they are grouped into series of about twenty to twenty-five extremely rapid vibrations, with periods between each two series during which the vibrations almost entirely cease.

The supposition that these vibrations are respiratory is strengthened by the fact that when the animal is immersed in water they cease entirely, the floor of the mouth and pharynx being then held permanently compressed against the upper wall, apparently for the purpose of excluding the water. In this respect Autodax differs markedly from Diemyctylus, where the pharyngeal floor may or may not vibrate while the animal is out of the water, but always has a constant, though much slower, up-and-down movement during aquatic periods of life, Gage (**'91**), Ritter (**'97**).

For the little published information we have regarding the reproduction of Autodax we are indebted to Dr. Van Denburgh. On July 25, 1895, this herpetologist received from Los Gatos, Cal., a female specimen of *A. iëcanus* with fifteen eggs. A note accompanying them stated that they were found "under the platform in front of a barn, in dry earth next the foundation wall, and about fifteen inches or more below the surface. . . . There was no water within ten or fifteen feet." Dr. Van Denburgh did not hesitate to consider the eggs to belong to the Autodax, as he found entirely similar ones in the ovaries of another specimen taken from the same locality on July 30 of the same year. The female accompanying the eggs had

numerous small ovarian ova. The eggs, the author says, were in the early stages of segmentation. Unfortunately, this is all the information he gives us concerning them, and he tells me now that he tried to keep them alive in order to watch their development, but that in this he was not successful.

The specimens upon which our observations have been made were found on the grounds of the University of California by one of the students. They consisted of an adult female and nineteen embryos, all in practically the same stage of development and well advanced. They were found slightly beneath the surface of the ground and close under the oversetting base of a large palm tree.

The student who found them stated that he noticed, as he was loosening the earth about the roots of the palm, a hole which he at first supposed to be a gopher hole, but on removing a little of the soil at this point the salamander and her eggs were brought to light. He says that on being uncovered and disturbed she "squeaked like a mouse." This sound was one of the first things that attracted his attention. This squeak is frequently produced by adults when first taken, but rarely while they are in confinement. They were on the south side of the tree; and as the ground in this palm grove is kept perfectly free from other vegetation, and the spot where the animals were located receives the full force of the sun's heat during the whole middle portion of the day, it will be readily understood, particularly when it is considered that this region had received no rain for at least two months, that the place was about as dry as it can become. There is a creek bed about fifty meters from the tree, but this had been dry for three months at least.

When brought to the laboratory in a box with some earth, the salamander was partly coiled around the eggs, and in this position she seemed at first inclined to remain, since she returned to the eggs several times after being removed. The following morning, however, she had left them and appeared to have entirely deserted her charge. As we had arranged her new habitation in such fashion as to make the conditions as nearly natural as possible, we concluded that it was useless to expect the parent to care any longer for her family, so deter-

mined to take charge of them ourselves, and to make use of her to settle by dissection various anatomical and physiological questions that had arisen.

From the evidence at hand, then, there can be no doubt that Autodax lays its eggs not only in the earth, but in earth that may be very dry; that at least most of the development of the embryo takes place after the eggs are laid; and that the female parent remains with her eggs most of the time during the development of the embryo.

For what purpose the female tends her eggs is not entirely clear, but it is almost certain that one end attained is the maintenance in them of the high degree of moisture essential to their development. We supposed, on receiving the embryos and learning of the place where they had been found, that it would be necessary, in order to insure their further development, to place them under conditions of temperature and dryness similar to those by which they had been surrounded in nature. We consequently prepared a terrarium with this end in view, but greatly to our surprise and consternation, on the following morning we found the eggs much shriveled and most of the embryos either dead or nearly so; and it was only by placing them in water and allowing them to remain there for an hour or more that we succeeded in restoring any of them to their former healthy, active state. Four embryos returned to full vigor; and by keeping these on damp earth, and thoroughly wetting them at least twice a day, they continued to develop apparently in a perfectly normal way, to the time of hatching, which was September 13, or about fifty days after they were taken.

How do the eggs in nature get the large amount of moisture necessary to their life and development? Through a long series of observations made under the direction of Professor E. W. Hilgard of the Agricultural Department of the University of California, during the past extremely dry season, it has been proven that plants draw moisture from the soil after a degree of dryness has been reached, which has generally been believed to be incapable of yielding any moisture to vegetation; *i.e.*, after microscopic water is no longer present. It may be that

this fact is not without significance for such animals as our land-dwelling salamanders also. But we can hardly believe that such moisture can do more than prevent evaporation to some extent. It does not appear to us possible that sufficient water to insure the development of the eggs can be derived from this source. Our specimens were always more or less completely covered, and as the earth on which they were kept was constantly wet almost to saturation, and as they were not subjected to the direct heat of the sun at any time during their confinement, the evaporation from them under the artificial conditions could hardly have been greater than that under the natural conditions; and it appears impossible that any such quantity of water could be drawn from the dry soil in which they were found as it was necessary to give them each day to prevent desiccation.

The possibility that the urine of the parent might be the chief source of moisture to the embryos was suggested by the large size of the urinary bladder, and it is by no means impossible that the suggestion is well founded. However, a study of the structure of the organ and a comparison of it with its counterpart in other species where it is certainly not put to such a service do not confirm the conjecture. The bladder of Autodax does not differ either in size or minute structure from that of Diemyctylus, for example, the young of which are hatched in water. In fact, the bladder of Diemyctylus is of the two-lobed type, while that of Autodax is not lobed, and hence may be looked upon as the simpler of the two.

(See Field (**'94**), for a discussion of the different types of amphibian urinary bladder.)

The Embryos and their Development.

As already said, there were nineteen embryos in our batch. Each was contained in a gelatinous capsule and was firmly anchored to a clump of earth by a narrow peduncle, about 8 mm. long, composed of the same material as the capsule. The peduncles were attached to the earth close together; in fact, their adhesive, expanded, attached ends were more or less confluent (Fig. 4).

The peduncles were twisted, and each appeared to be hollow. The capsules were rather thin and seemed decidedly leathery when the eggs first reached us — as was always afterwards the case if the eggs were permitted to desiccate to any extent. After having imbibed water, however, which they did very eagerly, they became much thicker and more transparent and showed clearly their gelatinous nature.

The capsules were almost perfect spheres, and in what might be considered their normal state as regards imbibed water, were about 6 mm. in diameter. When the capsules were moderately swollen, and their surfaces were washed clean, the black embryos and the very large yellow yolk-sacs could be distinctly seen through them; and many details of structure were studied from day to day on the living specimens as they continued to develop. Figs. 5 and 6 were drawn from living specimens.

FIG. 4.

Four days after they came into our possession one embryo was dissected from its capsule and was found to be 15.5 mm. long. Its fore and hind limbs were of nearly equal length and were about 2 mm. long. The toes had not yet appeared. The gills were very large, and were each composed of three broad membranous lobes (Figs. 5 and 6).

The facts of special interest concerning the embryos, and which, consequently, we consider somewhat more in detail, are the following:

(1) *The Great Quantity of Yolk in the Eggs, and the Vitelline Circulation.* — The yolk-sac of the embryo, measurements of which are given above, was 5 mm. in diameter. This is a little more than twice the diameter, or eight times the mass of the eggs of *Diemyctylus torosus*, a species of about the same size as *Autodax lugubris*, but one in which the eggs have about the character, as regards yolk, of amphibian eggs in general. Whether or not the egg is meroblastic we have been

unable to determine with certainty, though what evidence we have obtained points to the conclusion that they are of this type. We have been unable to find any trace of either nuclei or other protoplasmic material, or cell boundaries, in the sections of the yolk which we have made. But, of course, earlier stages of development will have to be studied before the point can be definitely settled.

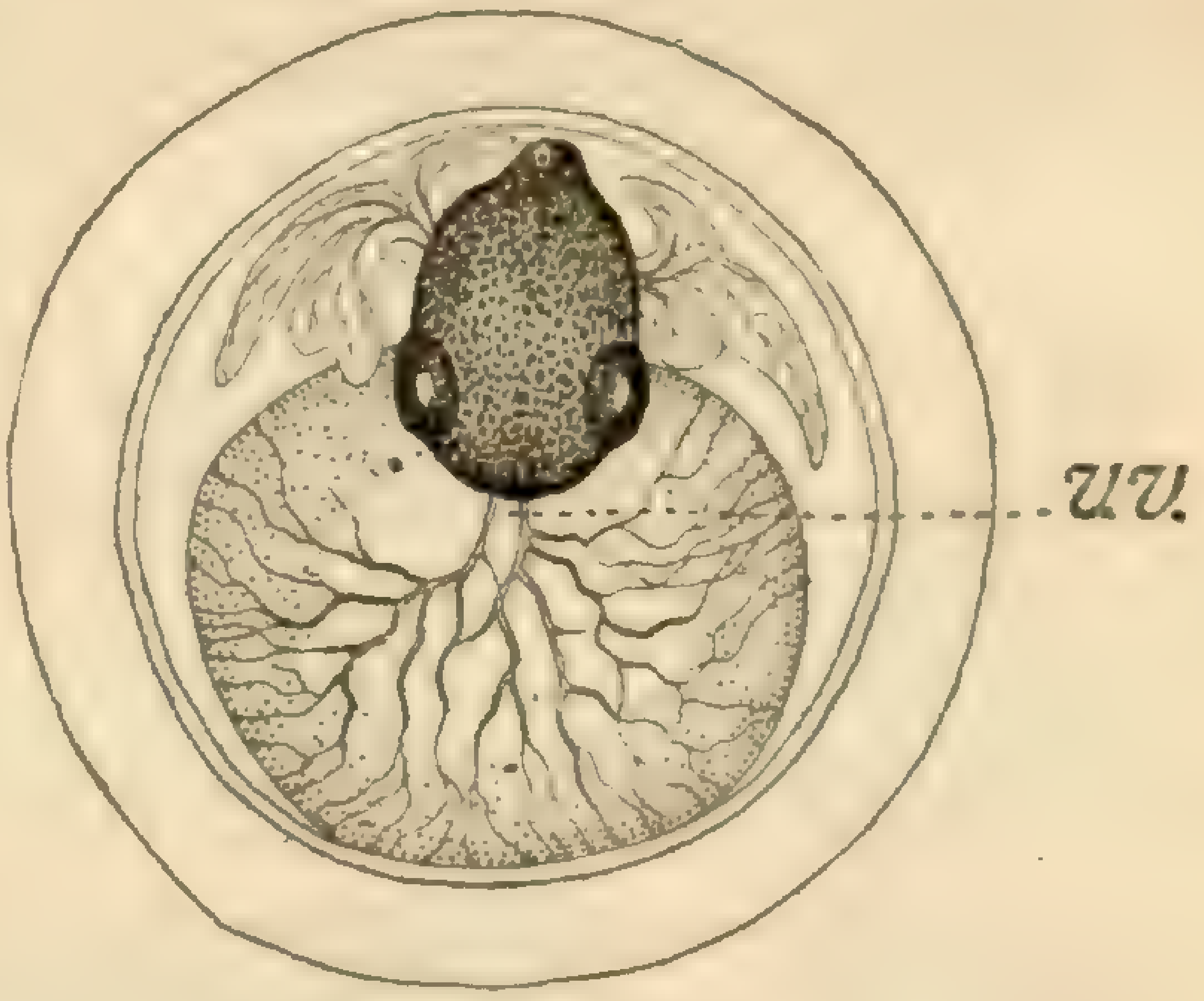

FIG. 5.

The entire surface of the yolk is covered by a very delicate epithelium which carries the vitelline vessels and capillaries. No pigment is present excepting in the embryo itself.

The general character of the vitelline vessels is shown in Figs. 5 and 6. The vitelline arteries, *v.a.*, are given off from the dorsal aorta in pairs, there being approximately a pair for each myotome of the abdominal region of the embryo. In all there are twelve or more pairs. The vitelline veins collect into a single large trunk (Fig. 5), *v.v.*, situated on the anterior side of the yolk-sac, and corresponding about to the sagittal plane of the embryo. The two trunks seen in the figure at the point of disappearance behind the head become confluent before actually entering the body.

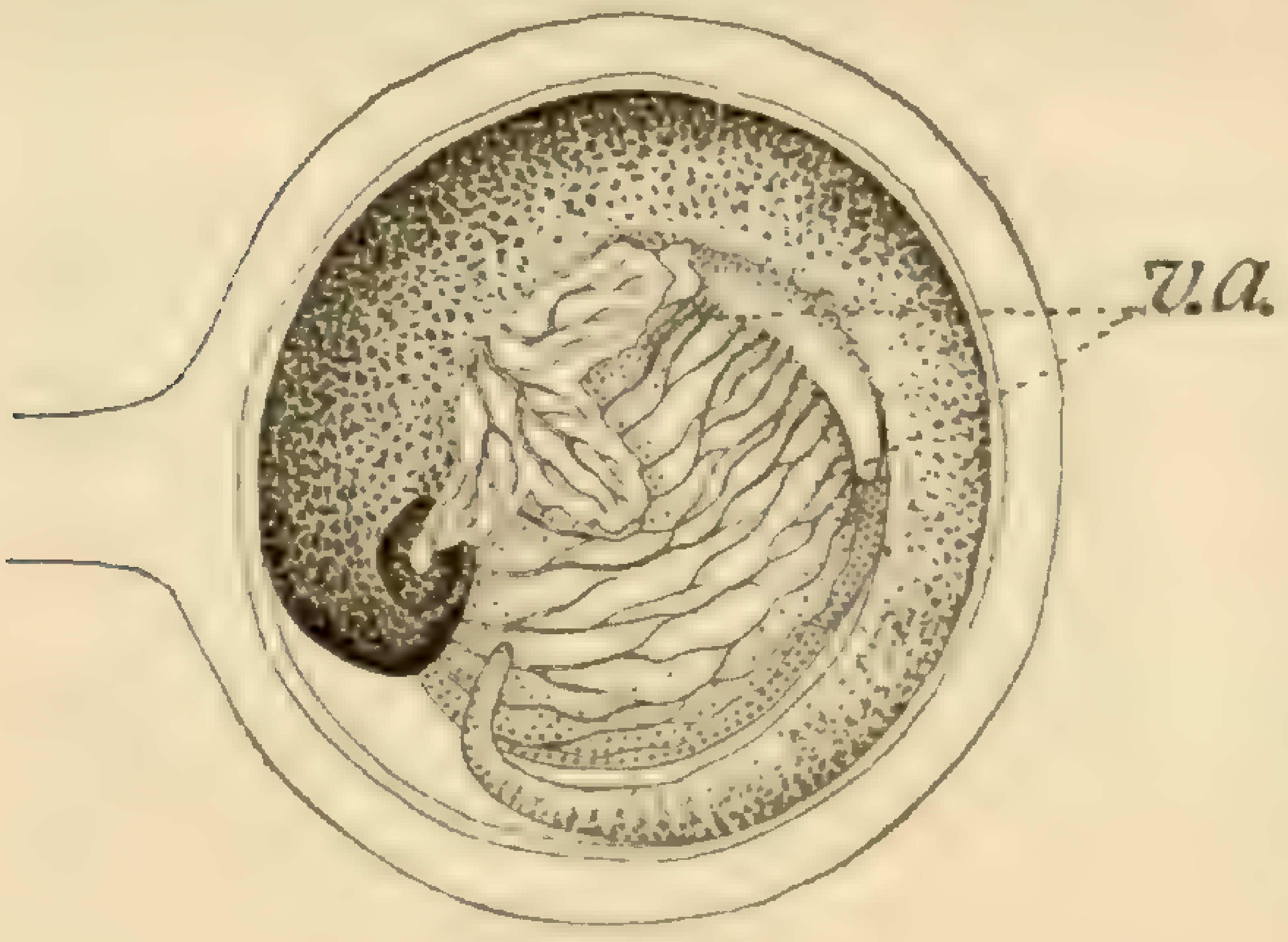

FIG. 6.

(2) *The Gills.* — These are of great size. They are three-lobed, the lobes being thin and delicate, much expanded, highly vascular, and widely confluent at their bases. The gills are so placed that their dorsal surfaces are close to, and concentric with, the inner surface of the egg capsule (Figs. 5 and 6). As they are functional during the intra-capsular life of the embryo

only, the term *allantoic gills*, first used by Gage ('90), I believe, is strictly applicable here. They begin at once to wither away when the embryo emerges from the capsule, the circulation being apparently cut off from them at that time. We placed one embryo in water immediately after its hatching and kept it there for some time, but could detect no trace of circulation in the gills, though it was always easily seen there during the intra-capsular life.

(3) *The Entire Absence of a Larval Period of Life.* — The young, at the time of hatching, possess none of the characters of aquatic amphibian larvæ. The external gills have, as already said, begun to wither and are not functional after the animal leaves the capsule. The gill-slits are imperforate, at least during the stages examined by us.

No suggestion of a dorsal and tail fin is present at any stage of development that has come under our observation. The tail is at all times as nearly round in section as is that of the adult. The just-hatched individuals, placed in water, appeared much distressed and were quite unable to swim. They sank immediately to the bottom and remained there until removed from the water.

The integumentary sense organs that are apparently invariably present in all aquatic urodele larvæ are, so far as we have been able to determine, entirely wanting here. We have carefully examined the skin both from the surface and on sections, and for various stages of growth, and always with negative results. Fig. 7 represents a specimen shortly after its escape from the capsule. The gills have almost entirely disappeared, and the abdominal walls are nearly closed over the yolk-sac. This specimen was 32 mm. long at hatching.

The color characters which distinguish the young during the first year have already been described. These are already assumed before escape, and are retained apparently until some time during the second year, when the almost black groundwork is changed to the dusky brown of the adult, and the fine silver specking is replaced by the much larger and less numerous yellow spots that mark the sides of the body of many of the adults.

In concluding this fragmentary contribution to the life history of this interesting salamander, we may remark that we are now directing our efforts to the securing of material, particularly embryonic material, that will enable us to complete the story. In the meantime we may call attention to some of the exceedingly interesting, but equally difficult problems of adaptation that are presented by our California salamanders.

The species of Autodax appear to be among the most terrestrial of American Urodela.[1] They are, nevertheless, lungless, and are possessed throughout life of a delicate, smooth, moist skin. *Diemyctylus torosus*, on the other hand, which has practically the same geographical range, and hence is subject to the same climatic conditions, while being thoroughly aquatic for a considerable portion of its life, has developed an exceedingly hard and rough epiderm well fitted to resist desiccation ; and, besides, it possesses well-developed lungs. In other words, the adaptive modifications in the two forms have gone in directions opposite to what might have been expected. We should have supposed that whatever the immediate influences may have been which caused the disappearance of the lungs, these would have been most potent in animals that passed the most of their time in water; and we should likewise have supposed that it would be just the animals that lived exclusively on land, in the air, that would have taken on the dry, hard, rough epiderm. And the case is the more puzzling from the certainty which we have, Wilder (**'94**), that in some species at least, and hence inferentially in all, the lungless condition is secondary and

Fig. 7.

[1] Wilder's (**'99**) recent interesting paper on *Desmognathus fusca* and *Spelerpes bilineatus* shows that the former species approaches Autodax in this regard, but here there is a true aquatic larval period despite the fact that the eggs are laid on land. *Plethodon oregonensis* and *Batrachoseps attenuatus*, two geographical neighbors to Autodax, will be found, we are quite convinced, to be entirely terrestrial; but full evidence on the point is not yet at hand. And Wilder (**'94**) gives reason for supposing that *Plethodon erythronotus* is entirely terrestrial.

not original. Were we permitted to suppose that the lungs had never existed in these species, we might then assume that the low grade of respiration required by the animals was taken on by the integument and buccal cavity when the gills disappeared, so easily that there was no particular demand for the production of lungs. But that *lungs already present should be lost by an air-breathing animal, and should be retained by a closely related water-living animal, is remarkable.*

BERKELEY, CALIFORNIA, April, 1899.

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THE WORCESTER NATURAL HISTORY SOCIETY.

HERBERT D. BRAMAN.

In 1854 some of the members of the Worcester Young Men's Library Association, leading spirits among them being Thomas W. Higginson and Edward Everett Hale, formed a branch for the study of natural history. Later the association gave its books to the city library and became "The Worcester Lyceum and Natural History Association," whose objects were: "The diffusion and promotion of useful knowledge among the inhabitants of the city and county of Worcester: (1) by courses of popular lectures; (2) by encouraging the study of natural history, and by the collection and preservation of specimens in the various departments, together with a library with a view to that end." Later the present name was taken.

Any resident of Worcester County, above the age of fourteen years, could become a member. The present membership is sixty, the fact that the privileges are free to all, keeping the membership small.

The charter of the society has just been changed by the present legislature, limiting the managing membership to fifty and providing for an unlimited associate membership, the details not having been fixed as yet.

Acting upon the advice of Louis Agassiz, regarding a collection, it has been the purpose of the society to gather and preserve such specimens as shall represent the life history of each species of the animals and vegetables in Worcester County, also its rocks and minerals; further, to illustrate from outside localities the subkingdoms of organic and inorganic matter.

The collection which has resulted consists in part of: Mammals, 63 species, 40 from Worcester County; birds, 400 species, 234 from Worcester County, with nests and eggs of 120 species; reptiles, 50 species, 25 from Worcester County; fishes, 70 species, 12 from Worcester County; insects, includ-

ing spiders and myriopods, 2434, from Worcester County; crustacea, 11 species, 3 from Worcester County; mollusks (represented by shells), 1500 species, 4000 specimens, 33 from Worcester County. Echinoderms and corals are well represented, and the lower forms by a collection of microscopic slides.

From the vegetable kingdom, pressed specimens (Worcester County, except some of the algæ), there are: Seed plants, 600 species; ferns, club mosses, etc., 40; mosses and liverworts, 148; fungi, 34; algæ, 137 (almost wholly marine); diatoms (slides), few.

The inorganic kingdom is well represented by about 2000 specimens; rocks and minerals from all parts of the world, among them being the representative rocks of central and southern Worcester County, and 57 species of minerals from the county.

This material, plainly labeled, is arranged in upright and horizontal cases and drawers in the rooms of the society building, at the corner of State and Harvard streets. The museum is open to the public without charge six days in the week, and is visited by about 6000 people yearly. There is an intelligent custodian in charge, ready to be helpful in every possible way to visitors.

Special displays are made from time to time upon the tables in the larger rooms. For instance, during the early part of last winter a display of the coniferæ of Worcester County was made, consisting of sprays of the foliage of each species, with the cones. Later were shown the winter birds of Worcester County — permanent and transient — first the hawk group, then the smaller birds, and finally the game and water birds. Two or three weeks are allowed for such exhibits, and at the same time articles are published in the daily papers describing them. During the past summer and fall the flowers and fruits of the county, as they made their appearance, were brought in and shown, marked with their common and scientific names.

The work is also educational, and the society encourages the use of its material by all interested in any branch of natural history. Its rooms are supplied with tables where one may

study specimens in the collection. It has a small reference library whose books are sometimes loaned. There are also two rooms for special study; one fitted up as a mineralogical laboratory, with gas fixtures, reagents, blowpipes, and other appliances, ready for use at any time; another fitted for use as a botanical laboratory.

For purposes of study, duplicate specimens are loaned as freely as books from a public library, and this is taken advantage of by the teachers of the city schools, who not only borrow objects for their own study, but for use in their class work. There were loaned to teachers and others during the last year: 344 birds, 18 nests, 30 mammals, 72 lots of minerals and rocks, 20 fossils, and a lesser number each of shells, charts, drawings, and books.

The society fosters the study of natural history by its yearly classes, many branches of the subject in the past having been covered. Those arranged for 1899, now under way, are: For the study of birds, two — one for adults, one for children; botany, two — one each for adults and children; elementary biology and microscopy, one; mineralogy, one. The class-room is not large enough to well accommodate the attendance at some of these classes.

The society gives a series of lectures each winter and spring, covering natural history subjects generally. It has also endeavored to popularize nature study by means of interesting articles in the daily papers of the city, on the mammals, birds, fish, frogs, toads, turtles, mollusks, flowers, minerals, and geology of the county, written by its members.

Again, the society aims to make its collection and work useful in all ways, as, for instance, in answering questions that may arise as to the best means of combating harmful plants and animals, and fostering those which are beneficial; also as to the economic values of woods, rocks, etc.

Two pamphlets have been published: *Flora of Worcester County*, by Joseph Jackson, Jr., 46 pp., 1883; and *The Physical Geography of Worcester, Mass.*, by Joseph H. Perry, F. G. S. A., 40 pp., 1898.

The society has invested funds of the par value of $6,500;

it also receives the income of $10,000 trust funds, for which it is obliged to give yearly in a neighboring town a course of six lectures on natural history, "at its own expense, by competent and able and well-known scientists." Other sources of revenue are the yearly fees and assessments of members, the renting of land owned by the society, and a "three-year fund" subscribed to by a few men who are willing to help the good work.

The society hopes in the future to work along the line laid down by Louis Agassiz for its collection, and to foster still more the use of its material in useful and educational ways, and for recreation. It only needs money to extend its influence.

SYNOPSES OF NORTH-AMERICAN INVERTEBRATES.

III. The Caridea of North America.

J. S. KINGSLEY.

In the preparation of this number of the "keys" now being published in the *American Naturalist*, it has been the endeavor to include all the shrimps and prawns reported from the waters of North America north of the southern boundary of the United States and within the 100-fathom line. It is believed that this key will serve for the identification of any species (except in the genera Hippolyte and Pandalus) now known to inhabit our waters; but the student may reasonably expect that several tropical species may later be found within these limits. The genera most likely to furnish additions of this character are Alpheus, Palæmon, Peneus, Atya, and Caridina.

In using the synopsis which follows, the student must remember that the characters of the key are not repeated. It will be seen that the mandibles furnish important characters. With a little practice these structures may be readily removed with the dissecting needle without injuring the specimen for exhibition purposes. Caridea should only be preserved as alcoholic material; any attempt to dry them proves disastrous. The terminology of parts employed below, with few exceptions, will be understood by any one who has dissected a cray fish or lobster. Branchiostegal spines are small spines just below the antennæ, near the anterior margin of the carapax. The carpal joint is the antepenult segment of the legs and is spoken of as annulate, where it is broken up into a number of smaller joints (see Fig. 39).

The geographical distribution of the species is roughly indicated by full-face letters following the specific name. These letters are: **A**, Alaska south; **D**, Monterey to San Diego; **M**,

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3a
4
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1a
2a
1b
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10a
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Cape Cod to North Carolina; **N**, Atlantic coast south to Cape Cod; **P**, Puget Sound to San Francisco; **S**, South Carolina to Florida.

The Caridea are aquatic decapod crustacea, commonly known as shrimps and prawns. Most of them are marine, but a few occur in the warmer fresh waters of the globe. The most important literature for the student of American forms follows:

SAY. Crustacea of the United States. *Journ. Acad. Nat. Sci.* Vol. i. Philadelphia, 1818.

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ORTMANN. Crangonidæ. *Proc. Acad. Nat. Sci.* Philadelphia, 1895.

Less important are: STIMPSON: *Am. Journ. Sci.*, II, vol. xxix (Ft. Macon, N. C.). — STIMPSON: Invertebrata of Grand Menan, *Smithsonian Contributions*, 1853. — GIBBES: *Proc. Am. Assoc. Adv. Sci.*, vol. iii, 1851. — BATE: (Puget Sound), *Proc. Zool. Soc. London*, 1864. — LOCKINGTON: *Proc. Cal. Acad. Nat. Sci.*, 1876. — LOCKINGTON: (Alpheus), *Ann. and Mag. Nat. Hist.*, vol. i, 1878. — KINGSLEY: (Alpheus), *Bull. U. S. Geol. Survey*, 1878. — KINGSLEY: *Proc. Acad. Nat. Sci.*, Philadelphia, 1878. — KINGSLEY: *Bull. Essex Inst.*, vol. x. — ORTMANN: Atyidæ, *Proc. Acad. Nat. Sci.*, Philadelphia, 1894. — HOLMES (California): *Proc. California Acad. Sci.*, II, vol. iv, 1894. — WALKER (Puget Sound): *Trans. Liverpool Biol Soc.*, vol. xii, 1898. — BENEDICT: *Proc. U. S. Nat. Mus.*, vol. xviii, 1895. — SMITH: *Rep. U. S. Fish Commission for 1872–73.* 1874.

KEY TO THE GENERA OF CARIDEA.[1]

1. Body usually cylindrical, elongate; antennæ long; abdomen large, usually extended, and bearing, as a rule, six pairs of feet (pleopoda), the sixth pair, together with the telson, forming a caudal fin . . . . MACRURA 2
1. Body depressed; antennæ small; abdomen small, and folded under the cephalothorax; no caudal fin formed . . BRACHYURA
2. Last pair of thoracic feet normal 3
2. Last pair of thoracic feet reduced and dorsal in position ANOMURA (pars)
3. Carapax with two longitudinal dorsal sutures; antennal scale small or lacking; cervical suture frequently present THALASSINIDEA.
3. Longitudinal sutures lacking; cervical frequently present; carapax united in front to epistome . . . . ASTACIDEA
3. Carapax not united to epistome, sutures lacking; antennal scale large CARIDEA 4
4. Not more than two pairs of feet chelate 5
4. Three anterior pairs of feet chelate . . . . PENEIDÆ 28
5. Mandibles slender, incurved, not expanded or bifid at the tip; no mandibular palpus (Fig. 11) . . . . CRANGONIDÆ 6
5. Mandibles stout, crown broad, dilated (Fig. 49) . . ATYIDÆ 14
5. Mandibles with the crown deeply bifid (Fig. 38) PALÆMONIDÆ 17
6. First pair of feet the stouter, subchelate (Fig. 1 *a*): *i.e.*, the movable finger closing on the palm . . . . CRANGONINÆ 7
6. First pair of feet the stouter; chelate . . . LYSMATINÆ 10
6. Second pair the larger . . . GNATHOPHYLLINÆ (extralimital)
7. Second pair of feet chelate 8
7. Second pair of feet not chelate . . . . . *Sabinea* 36
7. Second pair of feet obsolete, rostrum long . . *Paracrangon* 39
8. Branchiæ five on either side 9
8. Branchiæ seven on either side . . . . *Pontophilus* 37
9. Rostrum short, eyes free . . . . *Crangon* 29
9. Rostrum obsolete, eyes nearly concealed . . *Nectocrangon* 38
10. Rostrum long 11
10. Rostrum short, antennulæ biflagellate . . . . *Concordia* 45
11. External maxillipeds with exopodite 12
11. External maxilleped without exopodite . . . *Tozeuma* 42
12. Carpus of second pair triannulate 13
12. Carpus of second pair multiarticulate . . . *Hippolysmata* 40
13. Carapax with a median dorsal spine . . . . *Latreutes* 43

[1] The *American Naturalist* will undertake to determine and return any specimens that cannot be placed in the keys, and solicits correction and criticism for future revision.

13. Carapax without median spine . . . . *Rhynchocyclus* 44
14. Feet without exopodites; fresh water . . . . Atyinæ 15
14. Feet with exopodites; marine . . . . Ephyrinæ 16
15. Third pair of feet scarcely larger than the anterior pairs *Caridina* 46
16. Rostrum toothed, three anterior pairs of feet slender *Acanthephyra* 47
17. First pair of feet the larger, chelate . . . Alpheinæ 18
17. First and second pair of feet slender, the first not chelate (Pandalinæ) *Pandalus* 65
17. Second pair of feet the larger, both pairs chelate . Palæmoninæ 24
18. Mandible with palpus 19
18. Mandible without palpus 23
19. Carpus of second pair annulate 20
19. Carpus of second pair not annulate 22
20. Rostrum very short or absent 21
20. Rostrum moderate or long 22
21. Eyestalks short, eyes hidden under carapax . . . *Alpheus* 48
21. Eyestalks long, eyes free . . . . . . *Ogyris* 61
22. First pair of feet short, second slender . . . . *Hippolyte* 59
22. First and second pairs of feet subequal . . . *Caridion* 60
23. Carpus of second pair triarticulate . . . . *Virbius* 62
23. Carpus of second pair five-articulate . . . . . *Thor* 64
24. Mandibles without palpus 25
24. Mandibles with palpus; antennula triflagellate . . *Palæmon* 72
25. Antennula biflagellate, one branch divided at the tip . . . 26
25. Antennula triflagellate 27
26. Rostrum short; external maxillipeds broad . . . *Pontonia* 66
26. Rostrum long, slender; external maxillipeds slender . *Anchistia* 67
27. Rostrum toothed above only . . . . . *Urocaris* 71
27. Rostrum toothed above and below . . . *Palæmonetes* 68
28. Posterior pair of feet not annulate . . . . *Peneus* 74
28. Posterior pair of feet annulate . . . . . *Sicyonia* 76

Synopsis of North-American Caridea.

Family CRANGONIDÆ. First and second pairs of feet unequal.

Sub-family Crangoninæ. External maxillipeds pediform.

G. *Crangon* Fabr. Eyes free; antennulæ biflagellate; posterior feet acuminate.

29. Carapax strongly sculptured; at least two spines in the median line; abdomen usually sculptured 30
29. Carapax not strongly sculptured; one median and one lateral spine on either side 34
30. Median carina of carapax with three or four spines; abdomen longitudinally keeled 31
30. Median carina two-spined 32

31. Epimera of abdomen spined; carapax with more than three keels; rostrum simple . . . . . . *C. salebrosus* Owen **A**

31. Abdominal epimera without spines; carapax with three carinæ, the middle one four-spined . . . . *C. sharpei* Ortmann **A**

21. Middle keel three-spined . *C. boreas* (Phipps) Fabr. **A**, **N**, Fig. 2

32. Epimera without spinules; a median carina on abdomen, the sixth segment with two carinæ . . *C. intermedius* Stm. **A**, Fig. 44

32. Epimera without spinules; abdomen not sculptured . . . 33

33. Second lateral carina complete . . *C. munitus* Dana, Fig. 48

33. Second lateral carina extending half the length of the carapax *C. munitellus* Walker **P**, Fig. 31

34. A spine on each side of the posterior margin of fifth abdominal segment; palm very oblique . *C. franciscorum* Stm. **P**, **D**, Fig. 3

35. Fifth abdominal segment without spines *C. vulgaris* Fabr. **A**, **D**, **P**, **N**, **M**, Fig. 1

G. *Sabinea* Owen. Rostrum very short; eyes free, stout; second pair of feet short; branchiæ seven.

36. Rostrum obtusely rounded; telson subtruncate *S. septemcarinata* Ross **N**, Fig. 4

36. Rostrum and telson acute . . . *S. sarsii* Smith **N**, Fig. 5

G. *Pontophilus* Leach, Sars. Rostrum short, eyes free, second pair of feet very short.

37. Rostrum very short, tridentate . . . *P. brevirostris* Smith **M**

37. Rostrum longer . . . . . . *P. norvegicus* Sars **N**, **M**

G. *Nectocrangon* Brandt. Dactyli of fourth and fifth pairs of feet dilated.

38. Two spines in the middle line of the carapax behind the rostrum *N. lar* (Owen) Brandt **N**, **A**

38. Three spines behind rostrum . . *N. alaskensis* Kingsley **A**

G. *Paracrangon* Dana. Rostrum elongate, fourth and fifth pairs of feet acuminate.

39. . . . . *P. echinatus* Dana **P**, Fig. 54

—— Sub-family Lysmatinæ. Carpus of second pair annulate; external maxillipeds pediform.

G. *Hippolysmata* Stimpson. Four anterior pairs of feet with exopodites; first pair stout, second slender.

40. Branchiostegal spine present 41

40. No branchiostegal spine *H. wurdemanni* (Gibbes) Stm. **M**, **S**, Fig. 6

41. Flagella of antennula nearly as long as body; antennal scale tapering *H. intermedia* Kingsley **S**, Fig. 7

41. Flagella of antennula 1½ times length of body; antennal scale broad *H. californica* Stm. **D** Fig. 8

G. *Tozeuma* Stimpson. Body elongate, rostrum very long; external maxillipeds very short; carpus of third pair triarticulate.

42. . . . . *T. carolinensis* Kingsley **M**, **S**, Fig. 18

G. *Latreutes* Stimpson. First pair of feet with exopodites, carapax with a median spine.

43. . . . . *L. ensiferus* (M.-Edw.) Stm. Gulf weed

G. *Rhynchocyclus* Stimpson. Four anterior pairs of feet with exopodites, carpus of second triarticulate.

44. . . . . *R. parvulus* Stm. Texas

G. *Concordia* Kingsley. Rostrum very short; carpus of second pair biarticulate.

45. . . . . *C. gibberosa* Kingsley **M**, Fig. 17

Family ATYIDÆ. First two pairs of feet nearly equal, carpus of second pair not annulate.

Sub-family ATYINÆ.

G. *Caridina* Milne-Edwards. Rostrum prominent; carpus of first pair very short.

46. . . . . . *C. pasadenæ* Kingsley, southern California Fig. 45

Sub-family EPHYRINÆ.

G. *Acanthephyra*. Rostrum toothed; antennulæ biflagellate.

47. . . . . *A. pacifica* (Holmes) Fig. 52

Family PALÆMONIDÆ.

Sub-family ALPHEINÆ. Second pair of feet usually chelate; carpus frequently annulate.

G. *Alpheus* Fabricius. First pair of feet usually very unequal; carpus of second annulate.

48. Rostrum present; orbital hoods prolonged into spines . . . 49
48. Rostrum spiniform; orbital hoods not spined 55
48. Rostrum absent; orbital hoods not spined 57
49. Dactylus of larger pincer normal 50
49. Dactylus of larger pincer horizontal or inverted 54
50. Larger hand with both margins entire 51
50. Larger hand with margins constricted above and below . . 52
51. Feet of posterior pairs not spined beneath . *A. biunguiculatus* Stm. (*læviusculus* Lockington. Originally descended from Hawaiian Islands; may occur on west coast of United States).
51. Posterior feet spined below . . . . . *A. minus* Say **M**, **S**, **D**
52. A spine on basal joint of antenna 53
52. No spine on basal joint of antenna *A. websteri* Kingsley **S**, Fig. 13
53. Dactylus of smaller hand with straight lower margin *A. bellimanus* Lockington **D**
53. Dactylus of smaller hand with tooth near base *A. equidactylus*[1] Lockington **D**
54. No spine on basal joint of antenna . *A. barbara* Lockington **D**
54. Basal joint of antenna spined . . *A. clamator* Lockington **D**
55. Basal joint of antenna spined, larger hand constricted above and below *A. packardii* Kingsley **S**, Fig. 9

[1] Imperfectly known; larger hand lost.

55. Basal joint without external spine; dactylus normal . . . 56
56. Upper margin of large hand notched, lower entire
A. floridanus Kingsley **S**, Fig. 42
56. Larger hand constricted above and below
A. heterochelis Say **M**, **S**, west coast Fig. 43
57. Dactylus working horizontally . *A. candei* Guerin **S**, **D**, Fig. 36
57. Dactylus completely inverted 58
58. Hands of first pair equal . . *A. longidactylus* Kingsley **D**
58. First pair of hands unequal . . *A. harfordi* Kingsley **D**, Fig. 12

G. *Hippolyte* Leach. Rostrum not joined to carapax; external maxillipeds slender; first pair of feet short, equal. *Hippolyte* contains a large number of species, mostly from the colder seas. It is impossible to frame a key to the North American species at the present time. The following list includes the species found in our limits.

59. *H. affinis* Owen **D**, Fig. 15.
H. brevirostris Dana **P**, Fig. 57.
H. californiensis Holmes, Fig. 16.
H. cristata Stm. **P**.
H. esquimaltiana Bate **P**.
H. fabricii Kröyer **N**, Fig. 29.
H. gaimardii M.-Edw. **N**, **P**, Fig. 28.
H. gracilis Stm. **P**.
H. grænlandica (Fabr.) Miers. **N**, **A**, **P**.
H. hemphilli Lockington, California.
H. herdmanni (Walker) **P**, Fig. 21.
H. incerta Buchholz **N**.
H. lamellicornis Dana **P**, Fig. 50.
H. layi Owen **D**, Fig. 14.
H. macilenta Kröyer **N**, Fig. 33.
H. microceros Kr. **N**, Fig. 25.
H. palpator Owen **D**, Fig. 55.
H. panschii Buchholz **N**.
H. phippsii Kröyer **N**, **A**, **P**, Figs. 19, 24.
H. picta Stm. **D**.
H. polaris (Sabine) Owen **N**, Figs. 23, 26.
H. prionota Stm. **P**, Fig. 41.
H. pusiola Kr. **N**, **M**, Fig. 22.
H. securifrons Norman **N**, Fig. 39.
H. sitchensis Brandt **A**.
H. spinus (Sowerby) White **N**, **A**, **P**, Figs. 32, 46.
H. stylus Stm. **P**.
H. suckleyi Stm. **P**.
H. taylori Stm. **D**.

G. *Caridion* Goës. Rostrum elongate, three-jointed mandibular palpus, carpus of second pair obsoletely biarticulate.

60. . . . . *C. gordoni* (Bate) Goës **N**, Fig. 51

G. *Ogyris* Stm. Rostrum very short, mandibular palpus two-jointed; carpus of second pair triarticulate.

61. . . . . *O. alphærostris* Kingsley **M**, Fig. 35

G. *Virbius* Stm. Antennulæ biflagellate; carpus of second pair triarticulate.

62. No hepatic spine; antennal scale moderate.
V. acuminatus (Dana) Stm. Gulf weed
62. Hepatic spine present 63

63. Antennal scale moderate, rostrum elongate
V. zostericola Smith **M**, Fig. 30

63. Antennal scale as long as carapax; rostrum half as long as carapax
V. pleuracanthus Stm. **M**, **S**

G. *Thor* Kingsley. Carpus of second pair five-articulate.

64. . . . . *T. floridanus* Kingsley **S**, Fig. 20

Sub-family PANDALINÆ. Carpus of second pair multiarticulate.

G. *Pandalus* Leach. It is at present impossible to frame a key for the species.

65. *P. borealis* Kr. **A**, **N**.
P. danæ Stm. **P**, Fig. 27.
P. dapifer Murdoch **A**.
P. franciscorum Kingsley **P**.
P. gurneyi Stm. **D**.
P. hypsinotus Brandt **A**.
P. leptoceros Smith **N**, **M**.
P. montagui Leach **N**, **M**.
P. platyceros Brandt **A**.
P. pubescentulus Dana **P**, Fig. 53.

Sub-family PALÆMONINÆ. Carpus of second pair never annulate, feet without exopodites.

G. *Pontonia* Latreille. Rostrum short, external maxillipeds expanded, with exopodites.

66. Carapax smooth; dactylus of larger hand of second pair with two teeth
P. domestica Gibbes **S**

66. Carapax pubescent; dactylus of larger hand with one tooth
P. unidens Kingsley **S**, Fig. 40

G. *Anchistia* Dana. Rostrum long, slender; second pair of feet slender, equal.

67. . . . . *A. americana* Kingsley **S**, Fig. 10

G. *Palæmonetes* Heller. Rostrum long lamellate; antennal and branchiostegal spines present; fresh or brackish water.

68. Fresh-water species 69
68. Salt or brackish water species 70
69. Rostrum without teeth below *P. antrorum* Benedict. Well in Texas
69. Rostrum toothed below. *P. paludosa* (Gibbes) Kingsley, South Carolina, Great Lakes, Fig. 56.
70. Rostrum straight . . *P. vulgaris* (Say) Stm. **N**, **M**, **S**, Fig. 47
70. Rostrum recurved . . . . . . *P. carolinus* Stm. **M**, **S**

G. *Urocaris* Stimpson. Rostrum toothed above, toothless below; eyes elongate; sixth segment of abdomen very long.

71. . . . . *U. longicaudatus* Stm. **M**, **S**

G. *Palæmon* Fabricius. Rostrum lamellate; eyes free; mandibular palpus three-jointed.

72. Hepatic spine lacking, marine . . . . (S. G. *Leander*) 73

72. Hepatic spine present, fresh-water
P. ohionis Smith, Ohio and Mississippi rivers

73. Rostrum with 10 to 12 teeth above, 6 or 7 below
P. tenuicornis Say. Gulf weed, Atlantic

73. Rostrum with 7 to 8 teeth above, 3 below *P. ritteri* Holmes **D**, Fig. 37

Family PENEIDÆ. Third pair of feet the largest.

G. *Peneus* Labreille. Rostrum elongate, external maxillipeds with exopodites.

74. Both flagella of antennulæ very short; carapax sulcate near middle line . . . . *P. braziliensis* Latr. **M**, **S**, **D**[1]

74. Antennular flagella longer, no sulci near middle line . . . 75

75. Carapax without median carina, rostrum entire below *P. constrictus* Stm. **M**, **S**

75. Carapax carinate to nearly posterior margin; rostrum dentate below *P. setiferus* (L.) M.-Edw. **M**, **S**

G. *Sicyonia* Milne-Edwards. Rostrum short; carapax carinate; external maxillipeds without exopodite.

76. Two teeth on median carina and two minute teeth on the rostrum *S. carinata* (Olir.) M.-Edw. **S**

76. Three teeth on median carina and four on the rostrum *S. brevirostris* Stm. **S**

76. Three teeth on median carina, two on rostrum, the tip spined *S. lævigata* Stm.

76. Two teeth on median carina, three on rostrum *S. dorsalis* Kingsley **S**

[1] Possibly the specimens of *P. canaliculatus* of Holmes belong here.

LIST OF FIGURES.

1. *Crangon vulgaris.*
2. *Crangon boreas.*
3. *Crangon franciscorum.*
4. *Sabinea septemcarinata.*
5. *Sabinea sarsii.*
6. *Hippolysmata wurdemanni.*
7. *Hippolysmata intermedia.*
8. *Hippolysmata californica.*
9. *Alpheus packardii.*
10. *Anchistia americana.*
11. *Hippolysmata californica*, mandible.
12. *Alpheus harfordi.*
13. *Alpheus websteri.*
14. *Hippolyte layi.*
15. *Hippolyte affinis.*
16. *Hippolyte californiensis.*
17. *Concordia gibberosa.*
18. *Tozeuma carolinensis.*
19. *Hippolyte phippsii* (*turgida*).
20. *Thor floridanus.*
21. *Hippolyte herdmanni.*
22. *Hippolyte pusiola.*
23. *Hippolyte polaris.*
24. *Hippolyte phippsii.*
25. *Hippolyte microceros.*
26. *Hippolyte polaris* (*borealis*).
27. *Pandalus danæ.*
28. *Hippolyte gaimardii* (*gibba*).
29. *Hippolyte fabricii.*
30. *Virbius zostericola.*
31. *Crangon munitellus.*
32. *Hippolyte spinus.*
33. *Hippolyte macilenta.*
34. *Hippolyte gaimardii.*
35. *Ogyris alphærostris.*
36. *Alpheus candei.*
37. *Palæmon ritteri.*
38. *Palæmon ritteri*, mandible.
39. *Hippolyte securifrons.*
40. *Pontonia unidens.*
41. *Hippolyte prionota.*
42. *Alpheus floridanus.*
43. *Alpheus heterochelis.*
44. *Crangon intermedius.*
45. *Caridina pasadenæ.*
46. *Hippolyte spinus.*
47. *Palæmonetes vulgaris.*
48. *Crangon munitus.*
49. *Caridina pasadenæ*, mandible.
50. *Hippolyte lamellicornis.*
51. *Caridion gordoni.*
52. *Acanthephyra pacifica.*
53. *Pandalus pubescentulus.*
54. *Paracrangon echinatus.*
55. *Hippolyte palpator.*
56. *Palæmonetes paludosa.*
57. *Hippolyte brevirostris.*

THE LIFE HABITS OF POLYPTERUS.

N. R. HARRINGTON.

a. *Living* (*Resting*), b. *Feeding*; c. *Swimming*; d. *Breathing*; e. *Reproduction*.

REFERENCE has already been made to the occurrence of Polypterus in the Lower Nile (*Science*, Vol. V, 1898, Oct. 23, p. 54, and 1899, March 3, p. 315). The purpose of the present paper is to give a number of additional notes as to the occurrence and habits of this interesting and little-known fish. These details are treated in the following order:

Polypterus bichir differs but little in its habits from the other fresh-water fishes of the Nile. It lives in the deeper depressions of the muddy river bed, but it is an active swimmer and not essentially a bottom-liver or a mudfish. It is most active at night time when it is in search of its food.

Feeding. — Trawl lines were largely used as a means of collecting. They were laid late in the afternoon and left set all night. In the early morning, by three or four o'clock, besides many other large fish, a few Polypteri would usually be taken. Sometimes, however, specimens would be taken during the early morning in the second going-over of the trawls. Aside from small siluroids, Armoot, Bayad, Schilbe, Schal, which were commonly used as bait, Polypterus eats a great many other teleosts, as is evidenced by the more or less undigested remains in the stomachal pouch of such forms as Cyprinodon, Anguilla, and Chromis. It apparently catches them alive, for it prefers live bait and always swallows its food whole. Although catfish are usually taken head first, some fish were found in the stomachal pouch in a reverse position; their undigested remains are probably ejected through the mouth. The pouch is admirably adapted for resisting the very dangerous and strong spines possessed by all the catfishes.

On account of the great vitality of the siluroids they probably remain alive for some time after they are taken into the digestive

tracts ; but their strong pectoral and dorsal spines, which close backward against the body, are kept from doing any harm by the strong muscles of this gastric pouch, which compress the enclosed fish and prevent the erection of its spines.

Swimming. — Peculiar in the swimming movements of Polypterus is the manner in which the head moves freely from side. This produces the appearance of a progression more or less snake or eel-like, although in general the powerful sweeps of the strong tail characterize the progression as fish-like.

The pectoral fins were never observed to be used otherwise than are the pectoral fins of most other fishes, *i.e.*, primarily as balancing organs, but partly as organs of progression. There is no evidence that Polypterus uses its fins in the manner figured by Klaatsch in Gegenbaur's *Festschrift* (Vol. III) as organs for walking or crawling. The spreading cartilaginous pectoral fin rays give a mobility to the pectorals which is strikingly and beautifully displayed in a high development of the "trembling movement," so often seen in the balancing fins of teleosts.

The long dorsal fin is not always erect when the animal is swimming. It can be raised or lowered at will.

Breathing. — In spite of repeated observations, there is little positive evidence that Polypterus comes often to the surface to breathe. The evidence which can be presented concerns a number of fish, which were confined in a large wicker basket partially immersed in the river. In swimming around the narrow limits of this cage the Polypterus would stick its head out of water, but no more than would any fish similarly confined. On one occasion, while fishing a few miles above Damietta, we saw a Polypterus, about forty feet from us, thrust the anterior end of its body six inches out of the water, make two or three gasps, and then swim slowly away. But this fish, like many others found in the locality, was dying from the increased salinity of the water at this point, caused by the unusually low Nile and the backing up of the Mediterranean at high tide.

Although the fish was not often seen taking in air, the following fact goes to show that a respiratory function is possessed by the swimming bladders or lungs. When the fish is opened alive, a marked peristalsis may be observed making its way

along the right (larger) lobe of the so-called lungs. These structures open by the common large (about 2 cm. long) glottis into the pharynx, and they contain normally about four or five hundred cubic centimeters of air. A further discussion of the respiratory function of these bladders will be given later, when their histology can be discussed ; but their principal resemblance to amphibian or reptilian lungs is shown in the relations of the capillaries and the arrangement of the blood vessels running to and draining them.

Reproduction.

1. Migration. 2. Time and place of breeding. Manner of fertilization — size and character of eggs. 3. List of fish as to ovaries.

1. *Migration.* — Several of the fresh-water fishes found in the Nile migrate each season to the Mediterranean to spawn. This is the case with the eel (Hanash) and the several species of mullets. It has never been supposed that Polypterus could be found in any considerable numbers north of the second cataract, so that there seemed to be little likelihood that this fish migrated. When, however, fish were found in this lower part of the river more abundantly than in any other part known, except the head waters, it became a possibility that Polypterus had migratory habits. Investigation of the distribution of Polypterus at points intermediate to the second cataract and the mouth showed that in the large brackish Lake Menzaleh, an enlargement of the Delta, no adult fish could be got, although it was reported that two young Polypteri were obtained here the year before. The single specimen in the Natural History Museum at Cairo was the only one which had been seen in the local markets there for a number of years. At Assiout, 325 miles from the sea, the fishermen did not recognize the stuffed specimen shown them, but when the name, "aboubichir," was mentioned they said that such a fish was occasionally found there ; that it came from bad crocodiles' eggs and went down the river, while the good eggs brought forth young crocodiles that went up river!

The preceding facts as to distribution indicate that the fish does not pass by these several stations below the second cataract. It is, therefore, probable that the very considerable number of fish, which were taken over a limited territory, only a few miles in extent, were not individuals who were migrating, but fish that were living the year round in this locality. They were, in the full sense of the terms, healthy normal fish, and seemed to frequent certain holes, where they could repeatedly be taken with a circular throw-net. The males are smaller than the females, and although they are much less numerous, are generally taken in company with one or more females.

Aside from the lack of evidence as to Polypterus being a migratory fish that can be deduced from the facts of distribution, the continuance of mature individuals at Mansourah for a period of three months cannot be explained on the migration hypothesis. But the principal fact bearing against the latter view is that the adult fish is so affected by salt water that a slight increase in salinity kills it. On June 10, at Inanieh, a point four miles from Damietta, we came upon a number of dead Polypteri thrown up on the bank. The water was slightly brackish, and the fish evidently had been killed by some such particular cause. No other kinds of fish were found dead. The salt water, which had reached this point owing to the low Nile, continued to back up the river, until seven weeks later, August 2, it had reached Toela, some thirty miles from the sea. Being then stationed at Mansourah, a number of fish were brought in to us, which for the first time during our stay here were not fresh. Rigorous cross-questioning brought out the fact that they had been picked up dead upon the river bank at this town, Toela, which was now dependent on the canals for drinking water and irrigation, the Nile there being brackish. Several of the fish which had been killed by the salt water were heavily laden with eggs.

The chief reasons, therefore, for believing that Polypterus is not a migratory fish are : (1) It is unrecorded, in any numbers, at points intermediate between Mansourah and the second cataract; (2) females remain at Mansourah for several months longer than the actual time required for spawning ; (3) the

mature fish do not survive salt water long enough even to shed their ova.

2. *Place and Time of Breeding.* — If the specimens taken at Mansourah are not migrating, where and when does Polypterus breed? Probably at any point on the river where the adult fish may be found in numbers. Such regions are presumably to be found about the head waters of the Nile, and it is possible, further, that, like some other river fishes, they prefer the small brooks or springs for spawning. There seems to be no reason, however, why the few fish, which are found heavily laden with eggs at Mansourah, should not spawn in this vicinity, *i.e.*, below the first cataract; for it is practically impossible for them to pass the barrage. Besides the individuals taken with eggs, others were observed, the ovaries of which retained only here and there a few large ova still attached, the remainder having evidently been cast out.

The time of the breeding of Polypterus can be approximately determined not only by the gradual ripening of the eggs from June to September, but since the spawning seasons of nearly all Nile fishes correspond in a rough way, there is evidence that Polypterus probably breeds during or just after the inundation of the Nile. Cyprinodon, which brings forth its young alive, was one of the earliest fish to spawn, and its eggs had all disappeared before the middle of July. Between this time and the first of September, Schal, Schilbe, Bayard, and Armoot, in the order named, laid their eggs. The latter spawned latest, and its eggs during the summer seemed to keep pace in ripening with those of Polypterus.

Copulatory Organ. — The anal fin of the male Polypterus, which has already been described as being somewhat larger than that of the female, is undoubtedly a copulatory organ. When the fish is alive, this fin, if blown upon or irritated, assumes a hollow and pointed spoon-shaped appearance.

List of Fish Taken. — There follows a partial list of the fish taken during the summer, with occasional reference to the condition of the reproductive organs.

June 10. 7–8 bichir, principally dead females which carried large numbers of ova.

June 14. Two living bichir from Ras-el-Ghelig. Females with eggs.

June 15–20. Several dead brought in from banks of Nile

June 22. Two from market at Mansourah.

June 25. Two.

June 27. One.

July 2. Two males and two females. A promising but unsuccessful trial to rear larvæ was obtained from this material by means of artificial fertilization, the females bearing well-advanced eggs (which could not, however, be readily shaken from the ovarian stalk), and the sperm being fairly active.

July 3. One male with immature sperm.

July 4. Two females, both with eggs.

July 5. One male, two females.

July 6. Three females, one of whom had shot eggs.

July 7. Three females, all with eggs.

July 8. One female.

July 9. One female with eggs.

July 10. Three females, two large specimens with eggs, one small without.

July 11. Three females, two large with eggs, one small without.

July 13. One large female with eggs.

July 14. One large female with eggs, one small without.

July 15. Two large females with eggs.

July 16. One large and one small female, both with eggs.

July 17. One large female with eggs.

July 18. Two large females with eggs.

July 20. One female.

July 21. One small male, one large female with eggs.

July 22. Two females.

July 25. One small male, one female with eggs.

July 26. One small male and two large females, both with eggs.

July 27. Five females, all with eggs ; one small male.

Aug. 1. One very large male (rather smaller than average large female).

Aug. 2. Two large females, one had shot eggs.

Aug. 3. Three fish from Toela (salt water), one male, two females.

Aug. 4. One small male, one large male, one female which had shot her eggs.

Aug. 5. Five females, three with eggs, two had shot eggs ; all below average size.

Aug. 8. A pretty pair, male and female, apparently caught in same net. Female without eggs, male with striking copulatory anal fin.

Aug. 9. Three not designated.

Aug. 10. Two not designated.

Aug. 15. One not designated.

Aug. 21. Two, both females full of eggs.

Aug. 24. One large female with eggs.

Aug. 25. One.

Sept. 1. Female at Damietta with eggs.

A review of the above list shows plainly that the greatest difficulty we found in getting the developmental stages at Mansourah by artificial fertilization was the scarcity of mature males. There were only twelve males to fifty-eight females. Although sexually mature individuals of both sexes will be seen to have been brought in the same day, it was found exceedingly difficult to keep one promising specimen alive and healthy until an equally promising mate could be secured. As many as fifteen fruitless attempts were made to raise larvæ, by mixing sperm that moved actively with eggs which appeared ripe (although these could never be shaken from the ovarian stalks in large numbers).

This practical difficulty in keeping Polypterus in confinement is due to the fact that it is not an especially hardy fish. It will not survive more than three or four hours out of water, and only then under the most favorable conditions ; that is, covered with damp grass and weeds. The Nile catfishes Clarias and Bagrus, on the other hand, retain an unimpaired vitality after twice as long an exposure to similar conditions. It is well known that these catfishes have accessory branchial organs, and some species make considerable journeys overland. Physiologically at least, therefore, Polypterus has not evolved

very far toward a land-living or even an air-breathing type, although morphologically, *i.e.*, especially in its organs of respiration and circulation, it certainly presents the essential characters of the lower amphibia. They are feebly developed in some respects, but nevertheless include all the morphological and physiological potentialities of a higher vertebrate. On the other hand, in the possession of spiracles and in primitive skeletal characters, it strongly resembles the oldest fishes (Elasmobranchii). Several writers have recently contributed very convincing evidence that crossopterygians were lineal ancestors of the higher vertebrates, but judging from the conditions in Polypterus they were also sufficiently remote in the phylum of vertebrates to have given rise to both dipnoans and amphibians.

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May 12, 1899.

PADS ON THE PALM AND SOLE OF THE HUMAN FŒTUS.

ROSWELL H. JOHNSON.

In examining the soles of the feet of human fœtuses of two and three months, I have found four distinct dome-like elevations situated interdigitally along the line of the metatarso-phalangeal joints. Similar mounds were found in the corresponding position upon the palm, there being, however, only three true mounds in a transverse line. The thumb-index finger elevation was merely represented by the large thenar eminence. The reason for the absence of the true mound is probably that its presence would interfere with the opposition of the thumb. Upon the palm the mounds are less distinct, and in the older fœtuses the well-defined outline becomes lost, leaving only an elevation comparable to the "mounts" of the palmists, to which Wilder ('**97**) has called attention. The mounds on the sole are succeeded by the smooth "ball" of the foot of the adult in embryos of about one hundred millimeters in length.

Fig. 1. — Plantar surface of the right foot of fœtus, No. 259 Minot collection. The method of stippling causes the mounds to appear with too sharp outlines.

Unfortunately the poor preservation of many of the specimens resulting from the inevitable exigencies of their collection and preservation make it impossible to determine precisely the stage of development attained by the pads in the various cases. This difficulty and the gradual increase to a maximum with the subsequent gradual decrease prevent a precise statement of the stages of development of the fœtus where the pads are evident. The accompanying table shows the conditions found in the embryos examined, with the exception of a few cases of very

bad preservation. It is believed by the author that the variation shown is the result of the preservation and not a real individual variation. This cannot be definitely stated however.

No. in Collection.	Collection.	Length in mm.	Condition of Pads on Feet.	Condition of Pads on Hands.
67	H. M. C.	31	Slightly developed.	
58	P. & S.	36	"	Slightly developed.
2	P. & S.	42	Well developed.	Well developed.
32	"	44	"	"
21	"	55	"	Fairly developed.
249	H. M. C.	57	"	" Mounts " barely shown.
	N. Y. L. I. H.	65	"	
183	H. M. C.	69	Fairly developed	Fairly developed on one hand.
6	P. & S.	70	Slightly developed.	Not present as pads.
110	H. M. C.	76	"	"
20	P. & S.	80	Well developed.	Fairly developed.
149	H. M. C.	85	Fairly developed.	Not present as pads.
30	P. & S.	97	Not present.	"
8	"	100	Poorly developed.	Faintly developed.
3	H. M. C.	103	Not present.	Not present as pads.
216	"	104	"	"
51	P. & S.	105	Scarcely discernible.	"
10	"	115	Not present.	"
12	"	120	"	"
68	H. M. C.	120	Scarcely discernible.	"
239	"	150	"	"

H. M. C.=Harvard Medical School Collection.
P. & S.=Collection of College of Physicians and Surgeons, Columbia Univ.
N. Y. L. I. H.= " " New York Lying-in Hospital.

Sections (Figs. 2 and 3) show the pad to be the result of the growth of the mesodermic tissue beneath, rather than an epidermic thickening. A cross-section (Fig. 4) of the right hind foot of a cat embryo in the region of the Anlagen of the walking pads shows an essential similarity in their form, position, and structure with the mounds on the human fœtal foot (Fig. 2).

Since the interdigital position precludes the possibility of the mounds being merely contour lines resulting from the influence of the joints or digits, we may infer from the fact that the position is characteristic of walking pads that we have here structures of this kind. Further evidence lies in the fact that

in the baboons we have in the same positions upon the palm and sole strongly developed mounds with marked patterns of the epidermic ridges, and that in man there are upon the palms

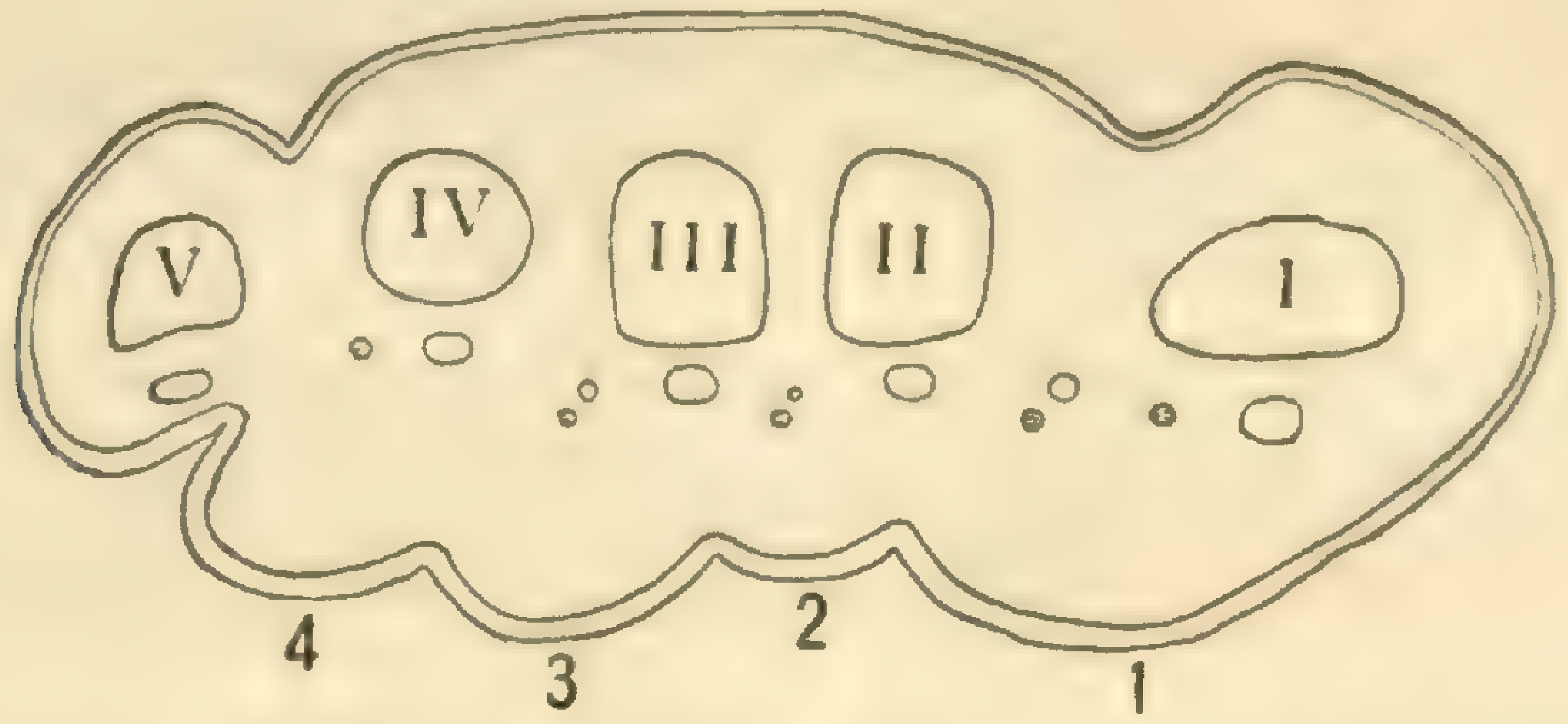

Fig. 2. — Cross-section of the left foot of the same fœtus. Section 193 G 48 in collection of slides in Harvard Medical School. Roman numerals = metatarsal bones. Arabic numerals = number of mound.

and soles "patterns" (Galton) or "centers of disturbance" (Wilder) of the epidermic ridges at these points. Seldom, however, do we find them all present upon one palm or sole.

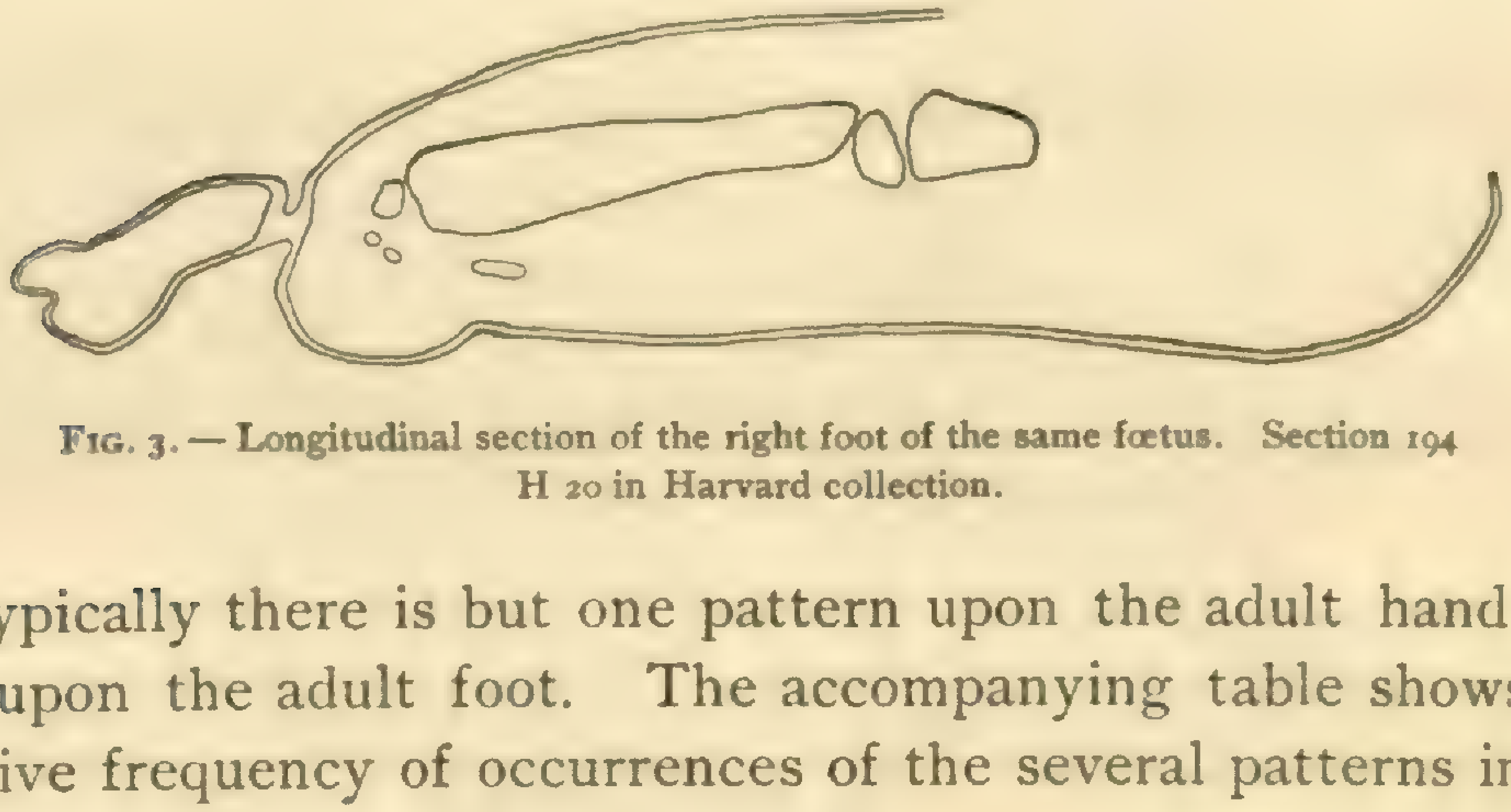

Fig. 3. — Longitudinal section of the right foot of the same fœtus. Section 194 H 20 in Harvard collection.

Typically there is but one pattern upon the adult hand and two upon the adult foot. The accompanying table shows the relative frequency of occurrences of the several patterns in the adult.

	Number of Thenar Patterns.	Number of Radial or Tibial Patterns.	Number of Median Patterns.	Number of Fibular or Ulnar Patterns.
200 hands.	17 = 8.5 %	13 = 6.5 %	129 = 64.5 %	62 = 32.5 %
41 feet.	39 = 95.1 %	9 = 21.9 %	32 = 78.1 %	5 = 12.1 %

It will be noticed that with the exception of the ulnar-fibular pattern the occurrence of any pattern is more frequent in the

case of the feet than in the case of the hands, as might be expected from the poorer development of the mounds upon the fœtal palm.

The ulnar-fibular pattern is remarkable not only for the fact that it is the only one of the four metatarso-phalangeal patterns which occurs less frequently in the feet than in the hands, but also for the fact that of these four "centers" it is the only one which occurs more frequently in the female than the male, as the following table shows.

	Cases in 100 Male Hands.	Cases in 100 Female Hands.
Thenar	12	5
Radial-tibial	9	4
Median	75	54
Ulnar-fibular	25	40
Hypothenar [1]	29	37

I am under great obligations to Dr. C. B. Davenport, for suggestions and criticisms; to Professor C. Sedgwick Minot, for kindness in allowing me to examine his collection of fœtuses

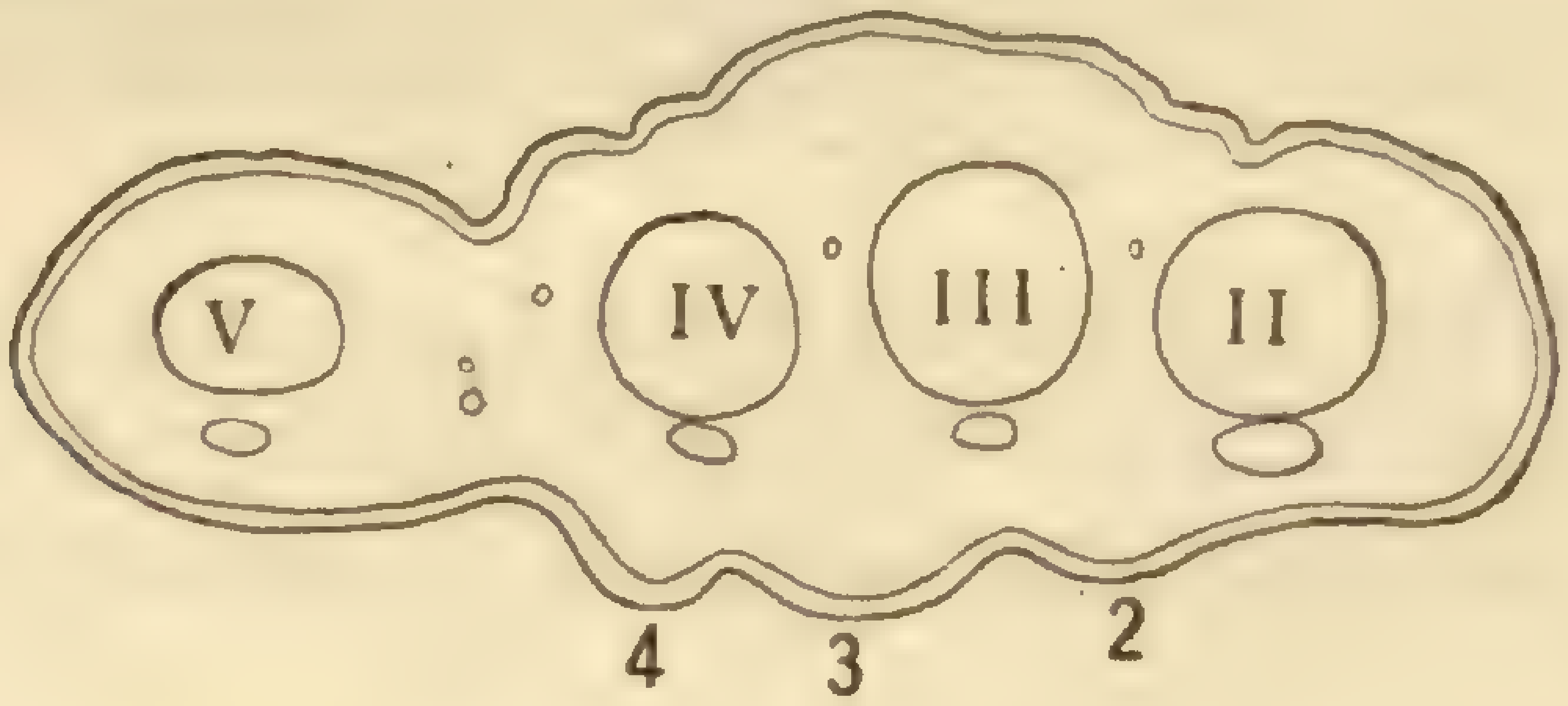

FIG. 4. — Cross-section of the right hind foot of a cat fœtus in region of the Anlage of the walking pad. Section 195 B 109 in Harvard collection. Roman numerals = metatarsal bones. Arabic numerals = number of mound.

and to section the feet figured, and for suggestions and criticism; to Professor H. H. Wilder, for the use of a series of footprints; and to Dr. J. A. Blake, for permission to examine the collection of fœtuses of Columbia University.

[1] The hypothenar pattern is one not in the metatarso-phalangeal series. See Figs. 5 and 6.

Conclusions.

I. There are upon the sole of the human fœtus of two to three months four mounds situated interdigitally along the line of the metatarso-phalangeal joints. Three mounds exist in a similar situation upon the palm of the fœtus of the same age. In the foot the mounds disappear. Upon the hand they persist as the less definite "mounts" of palmistry.

II. These mounds are homologous with the walking pads of some mammals, and have a direct relation to the "centers of disturbance" of the epidermic ridges upon the palms and soles of man and other primates.

Fig. 5. — Palm of a fœtus of *Evotomys gapperi.*

Fig. 6. — Palm of Inuus (from Kollmann after Purkinje).

III. Corresponding with a poorer development of these mounds upon the hand than on the foot in the fœtus, the "centers of disturbance" occur upon the foot more frequently than upon the hand in the adult.

Harvard University,
May 23, 1899.

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EDITORIAL COMMENT.

"New Species." — In a recent number of *Science* (No. 233) Mr. C. L. Marlatt speaks a necessary word as to some recent literature dealing with scale insects, pointing out that new species are being described upon entirely insufficient grounds. Every word of his short article is true; and, what is more, it is true in other fields than the Coccidæ. Every week brings to our table descriptive literature in which "new species" are founded upon the most trivial characters and new genera upon features of minor importance.

Mesenchyme *vs.* Mesenchyma. — There seems to be a growing tendency among writers on embryological matters to employ the word *mesenchyme* to denote the indifferent tissue of the middle germ layer. The word is taken from the German *mesenchym*, but pronounced as if it were *mesenkeim* in German. Why not use *mesenchyma?* It has good usage. It is not a foreign hybrid, and it belongs to a series of words that has been long in use, in botanical literature at least. We already have collenchyma, kenenchyma, parenchyma, prosenchyma, and sclerenchyma — why not *mesenchyma?*

Shade Trees. — One of the most crying needs of our larger cities is a concerted and intelligent popular movement for the planting and preservation of street trees. No one in the United States has done more to stimulate such action than William R. Smith, and the Massachusetts Horticultural Society has done well to publish in its *Transactions* for 1898 a lecture on the subject, delivered by him before the society in February, 1898.

"Easy Science." — *The Great Round World*, an excellent little juvenile newspaper, tells the children that a Siberian traveler has found a beautiful flower that blossoms in January, resembles the Convolvulus, a blossom lasting only a day, and on the third or fourth day has the ends of the fine anthers tipped with glistening diamond-like specks — the seeds. And this is called "Easy Science."

REVIEWS OF RECENT LITERATURE.

GENERAL BIOLOGY.

Rôle of Vexillary Organs. — To determine whether certain showy, so-called "vexillary" organs, external to the flower, have any part in attracting insects is the purpose of a series of careful observations by the veteran student M. Félix Plateau.[1] Two species are studied under prearranged conditions. One of them is *Salvia horminum*, whose strict stems are crowned with showy reddish or violaceous bracts, occupying the upper fourth of its height, with the small and inconspicuous flowers arranged in verticils, with green bracts lower on the stem. The question was: Would these showy tops, often mistaken by men for flowers, deceive the insects?

The insect visitors were mainly (more than 90 per cent) Hymenoptera, with a few Lepidoptera and Diptera. The bees, to which fertilization is mainly due, behaved as if the showy tops did not exist, passing directly to the flowers, and very rarely seeming to notice the "vexillary" parts. They behaved with the showy plants precisely as they did with other plants from which the showy tops had been removed, and just as they do with the wild germander (Teucrium), which has green tops.

The number and nature of the errors committed by insect visitors are tabulated in detail. These are mainly short haltings before the bracts without settling on them, and occur oftenest during passage from stem to stem and not on first approach. Including such slight mistakes, the Hymenoptera averaged but one error to fifty-five flowers visited; the Lepidoptera, one error to seven flowers visited. In case of the Lepidoptera (and Diptera also) the errors are oftener real errors, reaching even attempts at extracting nectar from the buds of showy bracts. These results add cumulative testimony to the acuter perceptions of the Hymenoptera.

Hydrangea opuloides was also studied; both the wild form, with a few showy, sterile, peripheral flowers to each of its cymes, and the

[1] Plateau, Félix. Nouvelles Recherches sur les Rapports entre les Insectes et les Fleurs; Étude sur le Rôle de Quelques Organes Dits Vexillaires, *Mém. Soc. Zoöl. de France.* Année 1898, pp. 339–375; 3 figs.

cultivated form (Japan rose), with flowers all sterile and showy. On the former the insect visitors were not numerous, and were limited to pollen-eating Diptera and Hymenoptera. These alight from the first upon the fertile flowers, passing directly over the sterile ones, making few even slight errors (Hymenoptera, one to seventy-seven visits ; Diptera, one to eighteen visits), making still fewer obviously complete mistakes. In the cultivated form the flowers are neglected altogether, or, retaining somewhere occasional anthers, attract a few Syrphus flies directly to these.

Having shown that the "vexillary" peripheral flowers are almost entirely disregarded by insects near at hand, M. Plateau proceeds to show that they do not exercise any special attraction at a distance, citing two facts in evidence : (1) that the peripheral flowers open several days before the fertile, and remain fresh for several days after the fertile have faded; and (2) that the very showy cultivated flowers, lacking pollen and perfume, attract no insects. He shows also that insects do not learn by individual experimentation the nature of the two sorts of flowers. Then he objects to the idea of their possessing hereditary instinctive knowledge on the very insufficient ground of analogy with birds which have to learn to recognize inedible larvæ by individual experience.

The search for a basis in observable facts for the theories of coloration long current is certainly most desirable : and while every one will acknowledge the value of the facts discovered, one may still think that they do not fully justify the general conclusion, that these so-called "vexillary" organs have no right to be so considered. For if one fully agree with M. Plateau, that the fertilization of the flowers in question "would not suffer from the absence of these parts" at the present time, still the old theory would serve to explain their origin in the past; and the fact that mistakes are still made is not to be disregarded.

The old explanation of the coloration of bracts, etc., has been so satisfactory and so applicable to many facts of different kinds, that in absence of any substitute one may feel reluctant to abandon it, especially while our knowledge of the nature of the apperceptions of insects is so meager that we may hardly judge by what means they discover the flowers. That insects should make mistakes is no part of the theory; it does not assume that the external showy parts should delay visitors or divert them from their proper course to the pollen or the nectar.

J. G. N.

ANTHROPOLOGY.

Man Past and Present.[1] — This admirable treatise furnishes us with a much-needed text-book of ethnography. It is a continuation of the author's so-called *Ethnology* treating the varietal divisions of mankind "more in detail, with the primary view of establishing their independent specialization in their several geographical zones and at the same time elucidating the difficult questions associated with the origins and interrelations of the chief subgroups, and thus bridging over the breaks of continuity between *Man Past and Present.*" Another object sought in this volume has been to emphasize the fundamental principles of anthropology: psychic unity, the factor of environment, and the significance of social and religious institutions. "From this point of view the present may be considered as a continuous illustration of the first volume, and students of such sociological subjects as the family, clan and tribe, totemic, matriarchal, and shamanistic usages, current views on primordial promiscuity and group marriages, early philosophies, theogonies, theories of the universe, assumed revelations involving sublime concepts of the Supreme Being in savage peoples of low cranial capacity, will here find some fresh materials not perhaps unworthy of their consideration." The two opening chapters deal in a summary way with origins and early migrations. Professor Keane restates his belief in a generalized proto-human form that overran the territory now occupied by the four primary divisions of mankind and from which they have sprung "by continuous adaptation to their several environments." The human character of the *Pithecanthropus erectus* remains is fully accepted and regarded as a true link between man and the generalized Simian prototype. No interval existed between the Old and the New Stone Ages. In the *Ethnology* Keane estimated the length of time that has elapsed since the beginning of the Neolithic Age at 100,000 years; he now questions whether this high figure ought not to be raised. The duration and relations of the Ages of Metal are briefly dealt with, and some account is given of the evolution of writing systems which usher in the Historical Period.

The main sections of the succeeding chapters are introduced by a conspectus of such salient features as: Primeval home; Present range; Physical characters; Mental characters; Main divisions.

[1] Keane, A. H. *Man Past and Present.* Cambridge, University Press, 1889. 584 pp., 8vo.

The terminology of the *Ethnology* is retained and the main divisions are designated "Ethiopic, Mongolic, American, and Caucasic." The Ethiopic division is considered in two groups — the African and Oceanic Negroes; the former includes the Sudanese and the Bantu-Negrito-Buschman-Hottentot tribes. The Oceanic Negroes are divided into sections — the Papuans, Australians, Tasmanians, and Negritoes. The Mongolic Branch is divided into the Southern, Oceanic, and Northern Mongols. The Americans are treated as a single race, fairly uniform in physical characters and mental traits, not indigenous in the absolute sense, since the human race is supposed to have originated in the Indo-Malaysian region, but resident in the New World since glacial times at least. Some attempt is made at subdividing the physical type into two groups — a dolichocephalic and a brachycephalic, the former including the Eskimos, Botocudos, and some others, the latter embracing the majority of the American aborigines, though the mean index is mesaticephalic (79). The long-headed division is derived from Proto-Europeans, the other division from Proto-Asiatics. The evidence adduced in the *Ethnology* in support of the belief that American culture has developed independently is restated with some additions.

The Eskimos are said to have ranged as far south as Massachusetts upon the evidence furnished by the Norse account. This describes the natives as "of small size, dark color, and broad features, using skin canoes (*hudh-keipr*) and harpoons unknown to the other natives, and eating a mixture of marrow and blood and what looked like raw meat." We grant that the Eskimos are shorter in stature, but they are not dark in color; on the contrary, they are very much lighter than the Indians. Their features are not so broad as those of the New England Indians; neither in bi-zygomatic, bi-maxillary, bi-jugal, nasal, or any other cranial breadth are they equal to the Algonquins. If the Eskimos in the time of Eric the Red indulged in raw flesh, marrow, and blood to any greater extent than did the Indians, there is absolutely no evidence to show that their descendants have done so. The grouping of all the long-headed Eskimos and Indians together (deriving them from a common European source) conveniently disposes of a perplexing problem, but with seemingly insufficient evidence.

The several Indian linguistic stocks are briefly described and the course of their migrations given so far as known. We note that the distribution of the Crees should be extended at least 1000 miles northwestward from the limits given by Keane. He criticises the

attempt made by American writers to generalize concerning the relations of the clan and gens from a study of American tribes alone; he shows that the matriarchal does not necessarily precede the patriarchal system in general, and that the clan "is still on defense even in North America."

Our author describes the temperament of the American aborigines as "moody, reserved, and wary"; we had supposed that this "conventional Indian" had been finally banished from scientific literature. The Indian doubtless exhibits such traits when in contact with the blight of civilization, but this is certainly not the case when he is among his kindred, as has been made known by several writers and as we have learned from personal observation among several tribes from the Arctic Sea to Mexico.

In the *Ethnology* no general divisions of the Caucasian race based upon physical structure were recognized, but in the present work the classification of Lapouge, Ripley, etc., is accepted and the entire branch is divided into the three groups: *Homo europæus*, *H. alpinus*, and *H. mediterranensis*. Concerning the generalizations of the "anthropo-sociologists" Professor Keane states his belief that "a huge superstructure seems to have been built upon very weak foundations." The comprehensive character of the work involves the brief treatment of many disputed questions regarding origins and relationships, yet the evidence is submitted for the most part with fairness and in a lucid and convincing style. Twelve plates of portrait types are given, some of them being reproductions from photographs of apparently indifferent quality.

FRANK RUSSELL.

Anthropological Notes. — In a paper read before the Anthropological Society of Paris, Oct. 6, 1898, M. Paul d'Enjoy declared that the black color of the teeth of the Annamese is due to the application of "noir animal et de la poudre de calambac," the process requiring much time and patience and not the result of betel chewing, as is commonly supposed.

In the *Revue de l'École d'Anthropologie* of June 15 are reported the investigations of Dr. Chemin upon the occurrence of bluish or slaty spots on the skin of Mongolian infants. These marks have been observed among the Chinese of the bay of Kouan-cheou-Han, Annamites, Minh-huongs, Chinese-Siamese metis, and among the Siamese of Bangkok. The spots disappear about the sixth year.

Mr. F. W. Rudler, in his presidential address, published in the *Journal of the Anthropological Institute*, Vol. I, Nos. 3 and 4, gives

an entertaining summary of recent progress in anthropology. With reference to the publication of an epitome of the *World's Work in Anthropology* he says: "In no English journal have we a systematic review of anthropological literature in any way comparable, for instance, with the valuable collection of classified "Referate" in the *Archiv fur Anthropologie*." "Experience, however, convinced me many years ago, when working on quite another subject, that it is practically impossible to organize a body of honorary contributors who can be relied upon for regular work of this kind." "Such work can never be systematically and satisfactorily done unless it is undertaken in a professional manner by a staff of paid contributors." The Address includes references to recent publications of unusual merit that awaken and extend a general interest in the science of anthropology.

In Vol. II, Part III, of the *Memoirs of the American Museum of Natural History* Mr. Harlan I. Smith describes the "Archæology of Lytton, British Columbia." No definite age is assigned to remains discovered, but some of them, at least, are several hundred years old. The conclusions reached by this careful observer are that the prehistoric culture of the region in question resembles that of the present inhabitants of British Columbia; slight differences are seen in the shape of the arrowheads, and in the ancient pipes which resemble those of Oregon and Washington. The style of the prehistoric carving suggests cultural relations with the Pacific coast tribes; the presence of seashells proves the occurrence of inter-tribal trade in the same direction. "On the whole, however, the prehistoric culture of the interior of British Columbia shows greater affinity to that of the western plateaus than to that of the North Pacific coast. Up to this time we have no evidence of a change of type or of a material change of culture since the earliest times of which we have knowledge."

In the *Annual Report* of the President of the American Museum of Natural History of New York for 1898 it is stated, in the account of the department of Anthropology, that "at no period in the history of this department has so much been done for its development or so many additions been made to its collections as during the present year." New laboratories and exhibition halls have been opened, and valuable collections from Central and South America have been installed. Of special interest are the specimens received from the parties engaged in the Jesup North Pacific Expeditions.

In the March number of *l'Anthropologie* W. L. H. Duckworth gives a brief account of a living anthropoid which he regards as an inter-

mediate form between the chimpanzee and the gorilla. "Johanna" has survived the vicissitudes of menagerie life for an unusually long period; she was kept in the zoölogical gardens at Lisbon for four years, was brought to America, and later was transported to England, where she has lived a year.

In the *American Antiquarian* for May appears "the first thorough, complete, and reasonably scientific investigation and description" of the quaternary deposits at Abbeville, France. The paper deals with the topography, fauna, and implements of the region.

O. T. Mason presents an admirable summary of "Aboriginal American Zöotechny" in the January *Anthropologist*. He divides the study into the following chapters: I, American Indian zoölogy, or ethno-zoölogy in America. II, Exploitive zöotechny — the activities associated with the capture and domestication of animals. III, Elaborative zöotechny — the activities practiced on the animal after capture. IV, Ultimate products of zöotechny and their relations to human happiness. V, Social organizations and corporations. VI, The progress of knowledge in zöotechny, including the growth of language. VII, Religion and the animal kingdom. The paper concludes with a table of the number of clans or gentes and the animal totems of the principal tribes.

In the April *Anthropologist* a timely article by Stewart Culin deals with the games of Hawaii; ninety-one in all are given, all amusements except the dance being included. Many of the ancient games have disappeared, yet the Hawaiians are a pleasure-loving people and have adopted many foreign amusements. The author says: "I have refrained from expressing any conclusions based on the material here presented. In general the games described may be referred to the continent of Asia or to recent European or American influence. There are several, however, which are more directly analogous to games played by the American Indians." A systematic comparison of these is promised in a forthcoming paper.

F. R.

ZOÖLOGY.

Nucleus of Mammalian Blood Corpuscles. — The blood of mammalian embryos, as is well known, contains numerous nucleated blood corpuscles. These in the adult give place to corpuscles which

after careful examination have been generally admitted to be non-nucleated. Within the last year or so Petrone has succeeded in demonstrating, by means of improved methods of fixing and staining, that the adult mammalian corpuscle contains a differentiated body which he believes to be the remains of a nucleus. This body has been the subject of a careful study by Negri,[1] who has satisfactorily identified it in the adult blood corpuscles of mammals, and who has also seen it in the blood of embryonic rabbits, where it exists in addition to the nucleus, thus showing that it is not to be regarded as the remains of an original nucleus. G. H. P.

Development of the Teeth in Rodents. — The development of the teeth in rodents, as worked out by P. Adloff,[2] shows that the ancestors of these mammals possessed a more nearly complete dentition than do the present forms. Many species show the rudiment of a first incisor which eventually disappears, the characteristic incisor of the rodent being the second, as compared with the dentition of other mammals. This homology was previously declared by Cope, on paleontological grounds, and now receives support from the embryological side. In the upper jaws of some forms, as, for instance, Sciurus, a rudimentary canine was found, while in the corresponding region of the lower jaw not even a dental ridge was observed. The lower jaw may sometimes show evidence of prelacteal germs, thus marking the rodents as forms in which three generations of teeth once occurred. The paper is concluded with a short discussion of the question as to which generation the rodent molars belong.

G. H. P.

Breeding Habits of Ornithorhynchus. — Notwithstanding the efforts which have been made within very recent years to ascertain the breeding habits of Ornithorhynchus, very little in reality is known. W. H. Caldwell, in his search for the eggs and young of this animal, found one female that had laid her first egg and had the second still in the oviduct; R. Semon was altogether unsuccessful in obtaining further observations. In view of this lack of information, the field notes of A. Topič, as communicated by Professor V. Sixta,[3]

[1] Negri, A. Ueber die Persistenz des Kernes in den roten Blutkörperchen erwachsener Säugetiere, *Anat. Anzeiger*, Bd. xvi, pp. 33–38, 1899.

[2] Adloff, P. Zur Entwickelungsgeschichte des Nagetiergebisses, *Jenaische Zeitschrift*, Bd. xxxii, pp. 348–410, Taf. xii-xvi, 1898.

[3] Sixta, V. Wie junge Ornithorhynchi die Milch ihrer Mutter saugen, *Zool. Anzeiger*, Bd. xxii, pp. 241–246. June 12, 1899.

are of special interest. According to this observer, Ornithorhynchus digs a burrow whose mouth lies below water level on the steep bank of a stream, and whose zigzag course leads to an enlarged nesting chamber at a level above high-water mark. The nest chamber is said to be as large as a platter and as high as a loaf of bread. The nest is lined with hair taken from the backs of the male and the female. On one occasion a nest was found with two eggs in it, both of which were unfortunately broken. At another time a female was observed suckling her two young. The female had no nipples. She lay on her back, and her young tapped with their bills about the small sieve-like openings of the mammary glands. The milk ran from these into a median groove on the skin formed by the longitudinal musculature, and from this groove the milk was taken by the young. The young remain in the nest till they attain a size of twelve centimeters, and when twenty centimeters in size they venture with the mother on the water.

G. H. P.

New Goby from Clipperton Island. — In the *Proceedings of the New England Zoölogical Club* for June 9, 1899, Vol. I, p. 63, Mr. Samuel Garman describes a new goby from Clipperton Island, off the west coast of Mexico, as *Gobius arundelii*. In the rather minute subdivision of genera adopted by Jordan and Evermann this species is probably referable to Aboma.

D. S. J.

The Chelæ of the Lobster. — The forms of the chelæ in lobsters have been reinvestigated by Stahr.[1] In the great majority of cases the European as well as the American lobster possesses two chelæ of typically different shapes. One is thin-walled, delicate, and provided with small teeth. The other is swollen and large, and has its biting surfaces covered with an irregular double row of knob-like eminences. The occurrence of these two forms of chelæ is not correlated with sexual differences or sides of the body. In the American form animals with both chelæ of the delicate type are of rare occurrence, but this condition is not so uncommon among the European lobsters. The delicate type of chelæ possesses teeth of four sizes arranged in eight-place intervals, and it may also carry an additional tooth not unlike those found on the heavier type of chela. Although the representatives of these two types are as a rule easily

[1] Stahr, H. Neue Beiträge zur Morphologie der Hummerschere mit physiologischen und phylogenetischen Bemerkungen, *Jenaische Zeitschrift*, Bd. xxxii, pp. 457–482, Taf. xx-xxi, 1898.

distinguishable, intermediate forms occur. The more delicate type is well supplied with tactile hairs.

The author believes the delicate type of chela to be the more primitive of the two. He rejects the explanation that it is a cutting jaw as contrasted with a crushing jaw, and believes that it represents an ornamental structure. The rhythmical arrangement of its teeth is dwelt upon, and he suggests that as a crustacean's eye plays over such a series it may receive agreeable impressions. The paper is well written in that the observational and theoretic parts are clearly separated.

G. H. P.

Cestodes of Aplacentalia. — Zschokke has just published [1] a most important article on the anoplocephaline cestodes, the immediate occasion of which was the examination of material brought from Celebes by the Sarasins. The specimens, fortunately well preserved, were taken from *Phalanger ursinus*, and represented two closely allied species of the genus Bertia. They proved to be new and were named *B. edulis* and *B. sarasinorum.* Regarding the specific name, *edulis*, Zschokke says that according to the report of the Sarasins, who obtained repeated and unimpeachable evidence of the fact, the tapeworms of Phalanger are hunted and eaten with gusto by the natives of Celebes. "Phalanger appears, by virtue of its parasites, to be subjected to more than one disadvantage!"

The anatomical structure of the two species is treated in detail. *B. edulis* is a large form, 660 mm. long with 1500 proglottids; *B. sarasinorum* has, on the contrary, a maximum length of 70 mm., with only 220 proglottids. Further differences are found in the manner of union of the excretory loops in the scolex, in the number, size, and arrangement of the sexual organs, and in many minor points, so that despite their similarity the two are undoubtedly good species. Closely related to them is *Tænia obesa* from *Phascolarctus cinereus*, while somewhat similar are *T. echidnæ* from *Echidna hystrix*, and *T. semoni* from *Perameles obesula.* Information on all of these forms comes from previous studies by Zschokke.[2] *T. festiva*, described in 1819 by Rudolphi from *Macroperus giganteus*, is undoubtedly an anoplocephaline form, probably of the genus Moniezia; it is only imperfectly known.

[1] Zschokke, F. Neue Studien an Cestoden aplacentaler Säugethiere, *Zeitschrift f. wiss. Zool.*, Bd. lxv, 3, pp. 404–445, Pls. xx, xxi, 1899.

[2] Die Cestoden der Marsupialia und Monotremata, *Semon, Zool. Forschungsreisen, Jenaische Denkschriften*, Bd. viii, 1898.

After an extensive and valuable discussion of the anatomical features of agreement and difference between the five species noted above, Zschokke enters upon a critical review of the subfamily Anoplocephalinæ. Of family characters the so-called pyriform apparatus of the inner shell is certainly variable and available at most for the determination of species. On the other hand, the presence of three shells is clearly distinctive.

All cestodes yet described from aplacental mammals belong to the Anoplocephalinæ, even those which are incompletely known. In that family these five species occupy a separate position, being clearly distinct from the Anoplocephalinæ of ruminants and certain apes, the genera Moniezia, Thysanosoma, Stilesia, from those of many perissodactyles and some rodents, the genus Anoplocephala, and from those of rodents, the genera Cittotænia and Andrya. There remains for their reception only the heterogeneous genus Bertia, and with this the *obesa-edulis-sarasinorum* group agrees in main features, constituting a distinct natural subdivision of the genus. The group *echidnæ-semoni* departs from Bertia, however, in not unimportant respects in which it is also unlike all other anoplocephaline cestodes, so that a new genus, Linstowia, is formed for these species. Prominent among the points characterizing it is the location of the vagina and vas deferens ventral to the longitudinal excretory canals and lateral nerve trunk, and of the narrow dorsal vessel marginal to the broad ventral vessel. In full agreement with repeated utterances of Stiles, Zschokke emphasizes here the taxonomic importance of the relative position of genital and excretory canals and longitudinal nerve trunks.

The diagnosis of the genus Bertia is rewritten in the light of this discussion and its species classed in three groups, of which only a single feature need be noted here. (*a*) Dorsal excretory canals remain actually dorsal to the ventral canals. Hosts, apes; species *B. mucronata* and *B. conferta* Meyner. (*b*) Dorsal canals lateral to ventral. Rodents. *B. americana* Stiles. (*c*) Dorsal canals mesal to ventral. Marsupials. *B. obesa*, *B. edulis*, *B. sarasinorum* Zschokke, and probably also *B. plastica* Sluiter from *Galeopithecus volans*. The type of the genus, *B. studeri* R. Bl., and *B. satyri* are so incompletely known that their position, as also the precise form of the genus, must remain at present uncertain.

For the new genus Linstowia, of which a summary diagnosis is also given, *L. echidnæ* A. W. Thompson is taken as type, and *L. semoni* Zschokke also included. Noteworthy is the fact that Lin-

stowia, while resembling the different groups of the genus Bertia, in individual respects, is yet relatively furthest removed from that group which is found in marsupials.

In a summary the author notes that all Tæniæ at present known from aplacental mammals belong to the subfamily Anoplocephalinæ, which is typical for herbivors, and are found in three genera, Moniezia, Bertia, Linstowia. Between the Anoplocephalinæ of placental and aplacental mammals there exists a certain anatomical parallel, corresponding to the similarity in their manner of life and nutrition. Pure herbivors, such as ruminants and the giant kangaroo, harbor the genus Moniezia. The marsupials, Phascolarctus, Phalanger, as also the placental Galeopithecus, live on leaves, fruits, and rarely also on insects; in them is parasitic a well-circumscribed subgroup of the genus Bertia. Finally the aplacental insectivors, Echidna and Perameles, are inhabited by a special genus Linstowia, for which a parallel from Placentalia is not at present known.

H. B. W.

Histology and Physiology of the Gastræadæ.—Under this head T. Garbowski[1] describes the results of some recent observations on *Trichoplax adhærens* F. E. Schulze, on which he bases certain theoretical conclusions.

He finds the body epithelia covered with a several-layered cuticle, through which project the cilia. Contrary to the statement of Schneider, these cilia are not continuous within the cytoplasm, but, as is shown by impregnation with gold chlorid, are merely outer processes of the cells. It is conclusively shown that the ventral epithelium possesses no digestive power. This function is assumed by certain cells of the loose body parenchyma. Undoubtedly only liquid food is assimilated, chiefly organic decomposition products. Other cells of the parenchyma, becoming fibrous in character, take a dorso-ventral arrangement and act as muscles. The so-called muscles of von Graff appear as artifacts under the action of certain chemical reagents.

The large spheres, regularly arranged in the parenchyma and usually described as fat bodies, are shown to be the intercellular excretory products of the animal and are closely comparable to the excretory vacuoles of the larger amœbæ. Those other yellowish brown globules, which have been variously interpreted as otoliths, spermatoblasts, etc., are more probably specimens of a symbiotic alga, Zooxanthella.

[1] Zur Histologie und Physiologie der Gastraeaden, *Bull. Internat. de L'Académie des Sciences de Cracovie*, February, 1899, pp. 87–98.

There has also been observed in Trichoplax a most interesting process of conjugation, in which two individuals become joined so completely as to leave no trace of the point of fusion. This process is preparatory to mechanical fission or architomy. That it always precedes this reproduction is yet to be proved. No other method of generation has been observed.

From the above facts is drawn the conclusion that Trichoplax cannot, as has been claimed by the advocates of Haeckel's Gastræa theory, be considered as a flattened gastrula. Neither is it related to the Plathelmintha, as stated by Böhmig, since the acœlous condition of certain Turbellaria is secondary, but that of Trichoplax is evidently ancestral.

The author considers it unnatural to place Trichoplax and the closely allied Treptoplax in a special group, the Placulæadæ, and to set them as the simplest type of the multicellular animals, Protacœlia, at the foot of the metazoan stem. It is claimed that the mere fact that the Protacœlia are not hypothetical, like the Gastræa, but really exist, is in itself disproof of Haeckel's gastræal phylogeny; that there is danger that the advocates of this theory, in their zeal for proof of the minutiæ may neglect the broader facts of development, which point so evidently to a varied origin of the Metazoa.

Trichoplax then, while it does not support the Gastræa theory, may yet serve as an important factor in the development of the true theory of metazoan embryology.

Harrison S. Allen.

Notes. — Gephyrea, collected at Christmas Island, Indian Ocean, are described by Shipley (*Proc. Zoöl. Soc.*, London, Jan. 17, 1899). Of the six species listed only one, *Thalassema baronii* Greef, is rare. In the same paper, *Physcosoma japonicum* Grube is reported from the coast of British Columbia, though previously known only from the western shores of the Pacific Ocean.

The supposed occurrence of *Synganus trachealis*, the gape worm, in the domestic duck, as recorded by various authors, has been definitely shown by Railliet (*Arch. Parasit.*, Vol. I, No. 4, pp. 626, 627) to be due to the mistranslation of an English letter!

Recent work on the Myxosporidia is the subject of a comprehensive review by Doflein (*Zoöl. Centralbl.*, Vol. I., pp. 361–379). Of great general importance is noted the opinion of the author that with better knowledge of both groups this order is approaching the Rhizopoda.

In the *Proceedings of the Academy of Natural Sciences of Philadelphia* for 1899 (p. 179) Mr. Henry A. Fowler describes a small collection of fishes sent to the academy from Tan-lan-ho River in China. The new species are: *Leuciscus farnumi*, *Leuciscus costatus*, *Nemachilus dixoni*, and *Nemachilus pechiliensis.* Mr. Fowler also (p. 118) publishes a short list of fishes of Jamaica in collections in Philadelphia. Of the twenty-five species none are new, although two or three are not common in collections.

The belated concluding number of Vol. XIV of the *Journal of Morphology*, dated September, 1898, has just appeared and contains the following articles: Budding in Perophora, by G. Lefevre; On the Morphology of Certain of the Bones of the Cheek and Snout of Amia Calva, by E. P. Allis, Jr.; The Location of the Basis of the Amphibian Embryo, by A. C. Eycleshymer; and The Cocoons and Eggs of Allolobophora Fœtida, by Katharine Foot.

The last number of the *Journal of Comparative Neurology*, Vol. IX, No. 2, contains, besides the usual editorial and literary notices, Nerve Termini in the Skin of the Common Frog, Part I, by G. E. Coghill; The Number and Arrangement of the Fibres forming the Spinal Nerves of the Frog, by Irving Hardesly; The Total Number of Functional Nerve Cells in the Cerebral Cortex of Man, and the Percentage of the Total Volume of the Cortex composed of Nerve Cell Bodies, calculated from Karl Hammarberg's Data, together with a Comparison of the Number of Giant Cells with the Number of Pyramidal Fibres, by H. B. Thompson; A Note on the Significance of the Small Volume of the Nerve Cell Bodies in the Cerebral Cortex of Man, by H. H. Donaldson.

BOTANY.

Weber's Cacti in Bois's Dictionnaire d'Horticulture.[1]—The compiler of this dictionary was fortunate in securing, as one of the many associate editors, Dr. Albert Weber as the authority for the order Cactaceæ. This was a wise selection in view of the fact that in all probability no other man to-day has such rich opportunities for studying the order, or has given so much careful consideration to it as Dr. Weber.

[1] Bois, D. *Dictionnaire d'Horticulture.* Paris, 1893. 4to.

As a surgeon in the French army during its occupation of Mexico he traveled in nearly every part of that country, and was always busy making observations and notes on the cacti. On his subsequent return to France he gathered together, in the gardens of Mr. Robert Roland Gosselin, a large collection of these plants, not only from Mexico, but from other countries as well; and with these he continued his study of the order, until now he is justly considered one of the best, if not the first authority on this family of plants. He was a constant correspondent of the late Dr. George Engelmann, the acknowledged American authority on the order, and their free exchange of opinions and of specimens was of invaluable aid to each.

Since a botanist would hardly expect to find original descriptions in a horticultural dictionary, it seems wise that these published by Dr. Weber be brought more conspicuously before the botanical public, and to that end they are here appended. The dictionary, not as yet completed, has thus far been issued in *livraisons* of thirty-two pages each. The date of issue of each *livraison*, as far as published, has been kindly furnished in a letter from the author, and the date given in the citation of the species is made to correspond.

Anhalonium trigonum Weber in Bois's *Dictionnaire d'Horticulture*, 90, June, 1893. This, in compliance with the rules of nomenclature, becomes *Ariocarpus trigonus* K. Sch. *Cereus Pasacana* Web. l.c. 281, published some time between Feb. 1894 and Feb. 1895; the exact date is not known. This enormous Cereus is the giant of the Argentine Cordilleras, as *Cer. giganteus* is that of the Mojave desert. *Echinocactus heterochromus* Web. l.c. 466, Sept. 1896. *Echino. Peninsulæ* Web. l.c. 467, Sept. 1896. *Echino. Saussieri* Web. l.c. 468, Sept. 1896. *Echino. microspermus* Web. l.c. 469, Sept. 1896. *Echino. Schickendantzii* Web. l.c. 470, Sept. 1896. *Mamillaria plumosa* Web. l.c. 804, Jan. 1898. *Mam. valida* Web. l.c. 806, Jan. 1898. *Opuntia hyptiacantha* Web. l.c. 894, April, 1898. *Op. myriacantha* Web. l.c. 894, April, 1898. *Op. pilifera* Web. l.c. 894, April, 1898. *Op. Quipa* Web. l.c. 894, April, 1898. *Op. quitensis* Web. l.c. 894, April, 1898. *Op. ursina* Web. l.c. 896, April, 1898. In this the specific name is suggested by the dense covering of long, coarse hair-like spines, which also give it the universally accepted common name of "Grizzly Bear Cactus." *Op. australis* Web. l.c. 896, April, 1898. *Op. Schickendantzii* Web. l.c. 898, May, 1898. *Op. Spegazzinii* Web. l.c. 898, May, 1898. *Pereskia Argentina* Web. l.c. 938, July, 1898. *Per. Guamacho* Web. l.c. 938, July, 1898. *Per. panamensis* Web. l.c. 939, July, 1898. *Per.*

tampicana Web. l.c. 939, July, 1898. *Per. Philippii* Web. l.c. 939, July, 1898. *Phyllocactus phyllanthus* Link. vars. *boliviensis* Web., *paraguayensis* Web., and *columbiensis* Web. l.c. 957, July, 1898.

Besides these descriptions of new species, Dr. Weber makes a number of new combinations in nomenclature which are here given, with sufficient synonymy only for identification. *Anhalonium turbiniforme* Web. (*Echino. turbiniformis* Pfeif.) in Bois's *Dict. d'Hort.*, 90, June, 1893. *Echinocactus latispinus* Web. (*Echino. cornigerus* DC.: *Cactus latispinus* Haw.) l.c. 467, Sept. 1896. *Echinopsis catamarcensis* Web. (*Cer. catamarcensis* Web.) l.c. 471, Sept. 1896. *Echinopsis minuscula* Web. (*Echino. minusculus* Web.) l.c. 471, Sept. 1896. *Echinopsis obrepanda* Web. (*Echino. obrepandus* Web.) l.c. 472, Sept. 1896. *Echinopsis Schickendantzii* Web. (*Cer. Schickendantzii* Web.) l.c. 473, Sept. 1896. *Mamillaria pectinifera* Web. (*Pelecyphora acelliformis* Ehrenb. var. *pectinata* Hort.) l.c. 804, Jan. 1898. *Opuntia cereiformis* Web. (*Grusonia cereiformis* Hort., *Cer. Bradtianus* Coult.) l.c. 897, May, 1898. *Op. spathulata* Web. (*Pereskia spathulata* Otto) l.c. 899, May, 1898. *Pereskia Amapola* Web. (*Per. horrida* Parodi., *Per. Bleo* Morong) l.c. 938, July, 1898. *Pfeiffera ianthothele* Web. (*Pf. cereiformis* Salm., *Cer. ianthothele* Monv.) l.c. 944, July, 1898.

C. H. T.

Fertilization of Cycas. — An important recent paper by Professor S. Ikeno,[1] of Tokyo, Japan, treats of the development of the sexual products and the process of fertilization in *Cycas revoluta*. Incidentally it throws light on the relationships of the Cycads, but its chief interest lies in its bearing on the general problems of cell structure and fertilization.

In the development of the archegonia within the endosperm, Ikeno distinguishes three periods corresponding with those which are recognized in the development of animal sexual products. These are:

1. A period of *division*, in which the archegonial cells are differentiated.

2. A period of *growth*, during which the central cell (egg-cell) of the archegonium attains a relatively enormous size, its nucleus alone being 75–120 mikra in diameter. The growth takes place at the expense of cells which surround the central cell, their nuclei being actively engaged in the formation of granular food substance which is passed on into the central cell through pores in the intervening cell walls.

[1] *Journal of the College of Science*, Imperial University, Tokyo, vol. xii, Pt. iii, pp. 151–214; Pls. X–XVII.

This is exactly parallel with what takes place in the growth of the shark's egg at the expense of its follicle cells, and reminds us also of similar processes in insect eggs.

3. A *maturation* period, in which the central cell is prepared for fertilization. This consists in a very unequal cell division, resulting in the formation of a small canal cell which rests as a small cap on the peripheral end of the large, oval egg-cell.

Pollination occurs in June or July, and is shortly followed by the formation of the pollen tube at about the same time that the archegonium is being differentiated. The changes which take place in the pollen tube leading to the formation of motile spermatozoa cover a period of two months or more, at the end of which period fertilization is accomplished, in September or October.

A pollen grain is spherical in form, containing three cells placed in a row, namely, a large "embryonal cell" and two small flattened "prothallium cells." The embryonal cell plays the principal part in the formation of the pollen tube, occupying a position near its growing tip, the prothallium cells meanwhile remaining quiescent at the opposite end of the tube. Having formed the pollen tube, which now lies imbedded in the endosperm, the embryonal cell seems to have performed its principal function, and it subsequently disintegrates.

The larger prothallium cell, the one which was next to the embryonal cell in the pollen grain, may be regarded as a primordial germ cell; it now begins to develop, passing successively through stages of division, growth, and maturation, corresponding to those which occur in animal spermatogenesis. In the first of these stages nuclear division occurs without division of the cytoplasm, one of the nuclei being thrown out into the pollen tube as the "Stielzelle."

Early in the second, or growth period, centrosomes appear in the germinal cell (spermatocyte, to use the terminology of animal spermatogenesis) on opposite sides of the nucleus. These are very large deeply staining bodies, which persist throughout the subsequent development and have an interesting fate. The spermatocyte attains a diameter of about 0.14 mm., its large nucleus being about 60 mikra in diameter, and the centrosomes 10–15 mikra (!) in diameter. The centrosomes, except for a few vacuoles which they contain, are solid structures, as is shown by the fact that they can be broken into fragments by pressure. Around them are seen faint cytoplasmic radiations.

Maturation is accomplished by the completion of the division

foreshadowed by the presence of the centrosomes during the growth period. Two hemispherical spermatids are thus formed, each containing a large nucleus and centrosome. Each spermatid metamorphoses into a motile (ciliated) spermatozoön of about the shape of the spermatozoön of Ascaris, so well known to zoölogists. During this metamorphosis the centrosome resolves itself into an elongated band-like structure in the cytoplasm ; from one side of it radiations are seen projecting. A process of the nucleus is for a long time directed outward toward the deep end of this band, indicating that the nucleus is concerned in the changes which are taking place. The centrosome band ultimately comes to lie in a long spiral of about five turns just under the curved surface of the cell. The cytoplasmic radiations emerge from the surface as a spiral band of cilia, which remain attached to the centrosome band as to a basal plate ; they form the locomotor apparatus of the spermatozoön. The greater part of the mature spermatozoön consists of a large nucleus, which is covered with a thin but perfectly distinct layer of cytoplasm, in which lies the centrosome band bearing the cilia.

Ikeno regards the centrosome band as homologous with the middle piece of the animal spermatozoön, the centrosome being known to pass into the middle piece in animal spermatogenesis ; the cilia he regards as corresponding with the flagellum of animal spermatozoa. In fertilization a spermatozoön makes its way through the fluid which has accumulated around the egg-cell, bores into the egg-cell and loses its cilia and cytoplasm, after which its nucleus moves toward the oval egg nucleus, sinking into a ready formed depression (Empfängnisshöhle) on its peripheral end. The sperm and egg nuclei now fuse completely, no centrosome being visible during the process, nor in the nuclear division which follows. In this division the spindle fibers do not converge at either end of the mitotic figure, but lie parallel with each other throughout their whole length. The entire absence of centrosomes during fertilization is strongly in contrast to what is known of fertilization in animals.

W. E. C.

Botrytis and its Host. — The relation of Botrytis to its host plants has recently been studied by Nordhausen.[1] With some preliminary account of the infection of living plants by this fungus through the surface of wounds, where by reason of the injured cells Botrytis may readily begin its usual saprophytic existence, he passes to

[1] Nordhausen, M. Beiträge zur Biologie parasitärer Pilze, *Jahrb. f. Wissenschaft,* Botanik, Bd. xxxiii, pp. 1–46.

the consideration of the infection of uninjured tissue. By means of injecting into plants water containing Botrytis spores, it was possible to note the effect of their germination far removed from the point of injury. He found that from the time when the spores in the intercellular spaces began to produce any sign of hyphæ, the near-by cells showed evidence of disorganization. The cell walls turned brown and ultimately also the cell contents, until eventually death of the affected parts ensued. By numerous experiments he arrived at the conclusion that this is due to the secretion of a poison by the germinating spore. Into the cells so killed the Botrytis mycelium can now readily make its way, and by further excretion of the poisonous substance spread, mayhap, through the whole tissue of the plant. According to the author, it is by this means alone that Botrytis is able to assume its apparently true parasitic habit, although the hyphæ cannot penetrate the living cells themselves. Experiments with Penicillium showed that this fungus has no such power of killing cells on which it is growing; in other words, that it does not secrete a poisonous substance, and can only penetrate cells which themselves are in a weakened or diseased condition. The relation of Botrytis to its host is simple compared with that of a true parasite, which usually induces complicated hypertrophies. With Botrytis it is simply a question of killing the cells to effect an entrance in the first place, and a continuance of this process to effect a further development of the fungus. A large class of plant diseases must be included under the same head. Under natural conditions, where infection takes place through an injured surface, the spread of the fungus resolves itself into the question as to whether the host plant can form an impermeable covering of wound cork faster than the hemiparasite can destroy the cells around the point of infection.

H. M. R.

Notes. — No. 15 of the new series of *Contributions from the Gray Herbarium*, by M. L. Fernald, deals with certain species of Eleocharis and Scirpus, and is published as No. 19 of the current volume of the *Proceedings of the American Academy of Arts and Sciences.*

A conspectus of the genus Lilium is published by Professor Waugh in the *Botanical Gazette* for April.

"Grazing Problems in the Southwest" and "Poa Fendleriana and its Allies" are the titles of two recent papers by J. G. Smith, published from the Division of Agrostology of the United States Department of Agriculture.

New fossil North American mosses are described by Kirchner in the eighth volume of the *Transactions of the Academy of Science of St. Louis*, and Mrs. Britton in the *Bulletin of the Torrey Botanical Club* for February.

A comparative general study of the seedlings of certain woody plants, and of the anatomy of the hypocotyl and epicotyl, is printed by Francis Ramaley in a recent number of *Minnesota Botanical Studies*.

Nevada and other Weed Seeds is the title of a bulletin, by F. H. Hillman, recently issued from the Nevada Experiment Station.

PETROGRAPHY.

Herrmann's Quarry Industry and Quarry Geology[1] is an elementary text-book on the composition and character of the rocks used for construction and ornamental purposes and on the methods employed in exploiting and finishing quarry products. It describes briefly the methods used in testing the strength and wearing qualities of building stones and gives a short account of the present condition of the quarry business.

So far as the discussion goes it is simple and straightforward, so that it may easily be comprehended by any one who possesses some little knowledge of mineralogy and geology.

The most interesting portion of the book is that devoted to the rocks quarried in Saxony. This comprises about 220 pages. It begins with a short description of the geology of Saxony. This is followed by a few pages of statistics, and then come descriptions of the different rocks quarried in the kingdom, with a statement of their scientific and technical characteristics, and remarks concerning their use.

Most commendable features of the volume are its excellent bibliography of scientific and technical works on minerals and rocks, its lists of Saxon dealers in museum material, of laboratories for the

[1] Steinbruchindustrie und Steinbruchgeologie. Technische Geologie nebst praktischen Winken für die Verwertung von Gesteinen unter eingehender Berücksichtigung der Steinindustrie des Königreiches Sachsen, etc., von Dr. O. Herrmann. Berlin, Gebrüder Borntraeger, 1899. xvii + 428 pp. Pl. VI; Fig. 17.

testing of building stones, of the museums and collections of minerals and rocks within the limits of the kingdom, and of articles in the geology of Saxony.

W. S. B.

Notes. — The lavas of the early Tertiary volcanoes[1] of the Absaroka range on the east side of the Yellowstone National Park consist of a repeated succession of hornblendic and micaceous andesites, basalts, pyroxene, andesites, and finally a series of great flows of basalts. With these are associated immense deposits of tuffs, agglomerates, and igneous conglomerates.

Cushing[2] describes the augite-syenite gneiss near Loon Lake in the Adirondack district, New York, as medium grained, grayish green rocks composed of feldspar, pyroxene or hornblende, quartz, and sometimes biotite or garnet. They are undoubtedly metamorphosed intrusive rocks that are intimately associated with gneisses of sedimentary origin. The feldspar is usually a microperthite, but there are usually present in all slides small quantities of oligoclase. The pyroxene is principally augite, but hypersthene is often associated with it. The quartz is in elongated cylindrical individuals. The rocks are autoclastic in structure and are also foliated. In composition they are close to akerite.

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	BaO	MgO	K_2O	Na_2O	P_2O_5	Loss	Tot.
63.45	.07	18.31	.42	3.56	2.93	.13	.35	5.15	5.06	tr.	30	= 99.73

It is plain from the analysis that the augite is essentially a calcium, ferrous, aluminous variety unusually rich in alumina. The microperthite is approximately Or_3 AC_5. The syenite is thought to be closely related in origin to the anorthesite of the district.

Baalow[3] gives excellent descriptions of some of the handsome autoclastic conglomerates met with in the Grenville and Hastings series of Ontario. They resemble very closely true conglomerates, but their genesis from banded rocks by dynamic agencies is clearly traced. The illustrations accompanying the descriptions are particularly interesting.

Pirssow[4] collected together in a few pages the evidence that points to the conclusions that the phenocrysts of intrusive rocks are often formed in place, and are not intratelluric. The reasons for this con-

[1] Presidential Address of Arnold Hague, *Geol. Soc. of Washington*, 1899.

[2] *Bull. Geol. Soc. of America*, vol. x, p. 177.

[3] *Ottawa Naturalist*, vol. xii, p. 205, 1899.

[4] *Amer. Jour. Sci.*, vol. vii, p. 271, 1899.

clusion are briefly as follows: porphyritic intrusive masses often possess peripheral portions completely devoid of phenocrysts; dykes connected with large intrusions may be free from phenocrysts, while the mass of the intrusions is filled with them; flat crystals are often arranged haphazard in sheet and dykes and not in obedience to any law of flowage; phenocrysts often enclose crystals identical with those composing the matrix which surrounds them, and, finally, phenocrysts are often surrounded by microlites orientated parallel to the bounding faces of the large crystal, indicating that the latter was growing after the former had crystallized.

The conditions governing the consolidation and crystallization of igneous rocks are decrease in temperature, chemical composition of the magma, the influence of mineralizing vapors, pressure and increasing viscosity. In the view of the author "the greatest determinant in the formation of rock structure is the ratio of time in the fall of temperature between the point where the insolubility and crystallizing moment of a compound begins to the increasing viscosity."

The Inwood limestone [1] in the northern part of Manhattan Island is cut by pegmatite dykes, some of which are well exposed a few blocks north of Fort George. Near the contact the limestone contains tremolite, biotite, and brown tourmaline, while the last-named mineral occurs also in the peripheral portion of the pegmatite.

[1] Eckel. *Amer. Geologist*, vol. xxiii, p. 122, 1899.

NEWS.

Dr. Arthur Hollick, of New York, is to complete the monograph, *The Later Extinct Floras of the United States*, left unfinished at the death of Professor Newberry. The plates were printed some time ago, and include the cretaceous and tertiary floras of the west.

Among the scientific expeditions of the present summer we note that of Professor J. C. Branner to study the coral reef of Brazil; two sent out by the American Museum (New York) to collect fossils in our western states; Dr. J. L. Wortman visits Wyoming to collect fossils for the Carnegie Museum in Pittsburg; Mr. Harrington and Mr. Sumner revisit Egypt in the hopes of obtaining the embryology of Polypterus; Professor W. A. Setchell goes with a party of botanists to Alaska to study the flora; the University of New Mexico will study the geology, botany, zoölogy, and ethnology of that territory; the Union Pacific Railroad invites 300 geologists to conduct geological investigations in the neighborhood of their lines; Mr. Alexander Agassiz, with a party of assistants, will spend several months in the study of the deep seas and the coral reefs of the South seas, the U. S. Fish Commission steamer *Albatross* being placed in his charge; Professor Libbey goes with a party from the University of Princeton to Greenland and will conduct deep-sea dredgings in the Arctic seas; an expedition from the University of Chicago to explore the ruins in the vicinity of Merida, Yucatan; Professor Charles E. Bessey studies the flora of western Nebraska; Professor John Macoun investigates the flora of Sable Island; Dr. John N. Rose goes to Mexico to investigate several points in economic botany; Drs. Trelease, Fernow, Coville, and Saunders visit Alaska under the invitation of Mr. E. H. Harriman; Dr. Luigi Buscaloni, of Turin, goes on a botanical expedition to the lower Amazon region; Alexis A. B. Birula, of St. Petersburg, goes as zoölogist with the Russian expedition which is to measure an arc of a meridian on the island of Spitzbergen.

Dr. Anton Dohrn, of Naples, and Dr. Melchior Treub, of Buitenzorg, Java, have been elected foreign members of the Royal Society.

The statue to Darwin in the museum of the University of Oxford was unveiled on June 14, the ceremony being preceded by an address by Sir Joseph Hooker.

A compromise has been effected by which the Academy of Natural Sciences of Philadelphia receives one-half of the bequest of $300,000 left it by the late Dr. Robert Lamborn.

Vassar College has been promised $25,000 towards a biological laboratory on condition that another similar amount be raised for the same purpose.

The death of Dr. Axel Göes, of Stockholm, Sweden, which occurred in August, 1887, has remained unchronicled in scientific journals until recently. He was well known for his researches on Crustacea and Rhizopods. He was 62 years of age.

Professor Douglas H. Campbell, of Leland Stanford University, and Dr. B. M. Duggar, of Cornell University, will spend the coming year in Europe.

Appointments to Fellowships: Johns Hopkins University: Lawrence Edmonds Griffin, zoölogy; Joseph Cawdell Herrick, physiology; George Burr Richardson and Richard Burton Rowe, geology. Bryn Mawr: Miss Elizabeth Towle, biology. Tufts College: Mr. Harrison S. Allen and Mr. George F. Morton, biology.

The following appointments in zoölogy have been made at Harvard University: Dr. F. W. Bancroft, Parker Fellowship; H. W. Rand, Virginia Barrett Gibbs Scholarship. C. W. Prentiss, S. R. Williams, and W. A. Willard have been appointed assistants in zoölogy.

H. M. Benedict, formerly Fellow in zoölogy at the University of Nebraska, has been chosen head of the Biological Department of the Nebraska State Normal at Peru.

Emerson E. McMillin has given the Ohio Academy of Science $250 with which to carry on scientific investigations, and declared his intention of giving the same amount annually, if the money is wisely expended. During the last session of the legislature, the academy put forth strong efforts to secure an appropriation for a topographic survey of the state to be undertaken in coöperation with the U. S. Geological Survey. The bill passed the Senate, but did not come to a vote in the House.

Appointments: Marshall A. Barber, associate professor of cryptogamic botany in the University of Kansas. — Miss Annie I. Barrows, assistant in zoölogy in Smith College. — Dr. George A. Bates, professor of histology in the Tufts College Dental School. — Mr. John G. Coulter, instructor in botany in Syracuse University. —

Dr. Deichmüller, of mineralogical and ethnological museum at Dresden, titular professor. — Dr. Julius Doeger, adjunct of the Austrian Geological Survey. — Mr. Ulysses S. Grant, professor of geology in Northwestern University. — Dr. R. G. Harrison, associate professor of anatomy in the Johns Hopkins University. — Dr. Herbertson, lecturer on physical geography in the University of Oxford. — Dr. F. D. Lambert, instructor in biology in Tufts College. — Dr. Frank R. Lillie, of the University of Michigan, professor of biology in Vassar College. — Dr. Florence M. Lyon, assistant in botany in Smith College. — Mr. Harold Lyon, assistant in botany in the University of Minnesota. — Dr. E. B. Matthews, associate professor of petrography and mineralogy in the Johns Hopkins University. — Dr. Elisa Norsa, assistant in the zoölogical cabinet of the University of Bologna. — Miss Winnifred J. Robinson, instructor in biology in Vassar College. — Dr. C. Schenck, docent for anthropology and ethnology in the University of Lausanne. — Dr. G. B. Shattuck, associate in physiographic geology in the Johns Hopkins University. — Mr. John Louis Sheldon, assistant in botany in the University of Nebraska. — Max Standfuss, docent in entomology, titular professor in the University of Zürich. — Dr. Franz Edouard Suess, assistant on the Austrian Geological Survey. — Mr. W. H. Wheeler, assistant in botany in the University of Minnesota. — Dr. J. L. Wortman, of the American Museum of Natural History in New York, curator of the department of geology and paleontology in the Carnegie Museum of Pittsburg, Pa.

Deaths: Franz Benteli, entomologist, in Bern, Switzerland, January 28, aged 75. — Dr. Otto Böckeler, a student of the genus Carex, in Varel, Oldenburg, March 5, aged 95. — Dr. Ludwig Büchner, titular professor and the author of *Force and Matter* and similar works, in Darmstadt, April 30, aged 75. — Carl Jonas Reinhold Elgenstjerna, botanist, in Nora, Sweden, March 25. — Charles Stuart Gregson, an English student of Lepidoptera, January 31, aged 81. — Friedrich Heppe, geologist, in Pretoria, South Africa, Aug. 8, 1898. — Dr. Theodor von Hessling, formerly professor of anatomy in the University of Munich, May, aged 83. — Dr. Joseph Armin Knapp, assistant in the botanical department of the Court Museum of Vienna, April 1. — Rev. James Digues La Touche, geologist, in Stockesay, England, February 24, aged 74. — Gottlieb William Leitner, a student of Asiatic anthropology, in Bonn, February 22, aged 58. — Dr. Giovanni Michelotti, paleontologist, at Turin, Italy, December 21, aged 84. —

Dr. Naudrad, bryologist, in Tahiti, November, 1898. — Dr. William Nylander, lichenologist, in Paris, March 29, aged 77. — Paolo Mach di Palmstein, student of Italian algæ, in Fiume, Italy, January 5, aged 28. — Dr. August Römer, conservator of the Natural History Museum in Wiesbaden, May 1, aged 74. — Joseph Stevens, geologist, in London, April 7, aged 81. — Dr. Thomas O. Summers, professor of anatomy in the St. Louis College of Physicians and Surgeons, January 19.

PUBLICATIONS RECEIVED.

(The regular exchanges of the *American Naturalist* are not included.)

Birch, De Burgh. A Class Book of (Elementary) Physiology, including Histology, Chemical and Experimental Physiology. Philadelphia, Blakiston, 1899. x, 273 pp., 8vo, 62 figs. — Bather, F. A. The Genera and Species of Blastoidea, with a List of the Specimens in the British Museum. x, 70 pp. — Cragin, Belle S. Our Insect Friends and Foes. New York, Putnam's, 1899. xix, 377 pp., 255 figs. — Schumann, K. Morphologische Studien. Heft ii. Leipzig, Engelmann, 1899. pp. 207–313, 6 figs. 7 marks.

Dall, W. H. Synopsis of the Recent and Tertiary Leptonocea of North America and the West Indies. *Proc. U.S. Nat. Mus.* Vol. xxi, pp. 873–897. Pls. LXXXVII, LXXXVIII. — Garman, S. Concerning a Species of Lizard from Clipperton Island. *Proc. N. E. Zoöl. Club.* Vol. i, pp. 59–62. June. — Garman, S. A Species of Goby from the Shores of Clipperton Island. *Proc. N. E. Zoöl. Club.* Vol. i, pp. 63, 64. June.

American Microscopical Society, Transactions of. Vol. xx, 369 pp. May. — *Georgia State Board of Entomology.* Bulletin No. 1. April. W. M. Scott, I, Legislation against Crop Pests; II, Dangerous Pests Described by the Board with Remedial Suggestions. 32 pp., 2 figs. — *Insect World, The.* Vol. iii, No. 5. May. — *Michigan Ornithological Club Bulletin.* Vol. iii, No. 2. April. — *Ohio State Academy of Science.* Seventh Annual Report. — *Ohio State Academy of Science.* Special Papers No. 1. Moseley, E. L., Sandusky Flora. A Catalogue of the Flowering Plants and Ferns, etc. 167 pp. — *Ohio State Academy of Science.* Special Papers No. 2. Kellicott, D. S., The Odonata of Ohio. A Descriptive Catalogue of the Dragonflies Known in Ohio, etc. vii, 114 pp. Plates and portrait. — *Rhode Island Agricultural Experiment Station.* Eleventh Annual Report.

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A MONTHLY JOURNAL
DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE

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NOTES ON EUROPEAN MUSEUMS.

OLIVER CUMMINGS FARRINGTON.

The accompanying notes were first made with no thought of publication, they having been jotted down for purposes of a report to the Trustees of the Field Columbian Museum and for personal use during a hurried tour taken in the fall of 1898 among some of the principal natural history museums of Europe. Shortly after my return, however, being handed by Dr. Hovey a copy of his "Notes,"[1] I not only considered them to be of much interest and value, but was led to reflect on the scantiness of museum literature in general, and the probable utility of even small contributions to the subject. I have, therefore, arranged my rambling memoranda on a plan quite similar to that adopted by Dr. Hovey, but without repeating his observations where they resembled mine. For a like reason I have not followed the geographical order of my travels, but have given first my notes on museums not mentioned in his article.

[1] Hovey, Edmund Otis. Notes on Some European Museums, *Am. Nat.*, September, 1898.

Vienna. — The magnificent building of the Naturhistorisches Hofmuseum, which has been open to the public since 1889, is probably the most costly structure in the world devoted to purposes of a natural history museum. It is in the form of a hollow rectangle, 554 feet long and 230 feet broad. It is lighted from the side by numerous long windows. Only the outer two-thirds of the building is devoted to exhibition halls. The inner third is used for work and storage rooms, study collections, etc. This arrangement has the advantage of securing the best light for the exhibition halls and of making the work and storage rooms closely adjacent to the corresponding collections. It is also to be noted that the arrangement of the halls is such as to compel a consecutive line of progress from the single entrance and back to it again. A unique and pleasing feature of the interior decorations is the adornment of the walls of many of the halls by paintings which relate to or illustrate the collections. Of the thirty-nine halls, five are devoted to the mineralogical-petrological collections and five to the paleontological. The first hall of the mineralogical series contains what is termed a terminological collection in which the forms, properties, and genesis of minerals are illustrated. The two adjoining halls and part of a third contain the systematic mineral collection arranged according to Groth's system. The second of these halls contains as well the collection of precious stones and a collection of ores. The remainder of the third hall is occupied by a collection of building materials, marbles, etc., while in Hall No. 5 are the systematic rock collection and the world-famous collection of meteorites.

The cases adopted are, for the floors, desk cases of mahogany with pyramidal tops of low slope; for the walls, vertical cases of mahogany about 8 feet high and 2 feet deep, on bases 3 feet high. The floor cases accommodate only small specimens; the large specimens are shown in the wall cases. The case interiors are black. The method of mounting employed is that of black walnut blocks.

One difficult problem in mounting, *viz.*, a proper installation of cave specimens, seems to have been solved in this museum. The stalactites are fastened to individual wooden shelves pro-

jecting from the back of a wall case. The label, being then placed over the front of the shelf and projecting below it, hides any imperfection of the joint.

The collection showing varieties of marble is large and complete, and is the only collection which I saw in Europe having the different varieties fully and accurately labeled. Another commendable feature of the labeling of these and specimens of building stones is the use of a supplementary label (of a yellow color) upon which are mentioned important buildings or works of art in the construction of which the different stones have been used. The only criticism I would make on this collection is that the specimens are too small, being only 3 x 4 inches in size, to adequately represent the varieties. The marbles and building stones form a part of a collection of structural material, all of which is arranged geographically and is divided into the groups of road material, paving material, raw material for bricks, mortar, sand, raw material for cement, building stones, decorative stones, roofing slates, and marbles. Introductory to the systematic rock collection is a so-called terminological collection, made up of the following: rock-forming minerals, rock structures (amorphous, crystalline, conglomerate), varieties of structure of crystalline rocks, varieties of structure of clastic rocks, modifications of stratified rocks, modifications of massive rocks, accessory modifications, inclusions, and rocks of sedimentary, eruptive, and metamorphic origin. The classification adopted for the systematic collection is that of Kalkowsky, as given in his *Elemente der Lithologie*. The specimens are of the uniform size, 3 x 4 x 1 inches, and are labeled as to locality and species. Supplementary to this collection are suites of rocks from different volcanic regions, such as the island of Teneriffe, Bourbon, and Vesuvius. The great meteorite collection, which is not only the greatest of its kind in the world, but is also considered the most costly and valuable of any collection in the museum, is exhibited for the most part in floor cases of the uniform type, but some of the larger specimens are shown in two separate upright cases. The main collection is systematically arranged according to Tschermak's classification. There are also several accessory collections which illus-

trate the history of meteorites, their constituents, forms, and structures. The smaller specimens are mounted on circular, ebonized blocks, the larger ones on individual mounts adapted to each specimen.

In the paleontological division the arrangement of the collections is in order of time, beginning with the earliest and extending to the period of man. The fossil plants are placed in a series by themselves and occupy the first hall. With them are shown such indeterminate forms as Arthrophycus, Cruziana, and Bythotrephis. In the next hall, seeming somewhat out of order, is a dynamical collection arranged on a classification of Professor Heim of Zurich, also large specimens of ripple marks, basalt columns, glacial markings, etc. There are also shown stratigraphic series arranged in vertical order. In the three remaining halls follow, in order, specimens of the faunas of the Paleozoic, Mesozoic, and Cenozoic ages, the last, of course, occupying much the largest relative space. Together with each of these are shown series of the typical rocks, chiefly from Austrian localities, of the strata of each age. The only feature of installation especially noted in the collection of fossils was the method employed for mounting incomplete skeletons. Black plaster forms having the shape of the body cavity and containing properly shaped depressions for each bone are prepared and the bones mounted on them. In this way the general form of the animal is presented to the eye and the bones are easily removable.

The museum is free to the public on Sundays, Thursdays, and holidays. Mondays, Wednesdays, and Saturdays payment is required of 1 krone (about 20 cents). A charge of 20 hellers (about 4 cents) is made for checking umbrellas, canes, etc.

Dresden. — The natural history collections are contained in the building of the rococo-baroque style of architecture which is the home as well of the art gallery so well known to European tourists. It is not to be expected that a building of this type would be well suited to the purposes of a natural history museum, and it is pleasing to note that plans for a new structure, expressly for the purposes of the natural history museum,

are already under way. Yet many of the peculiarities of the present building have been turned to good account in the present installation, and the museum furnishes a good illustration of how much a little ingenuity will do in overcoming limitations of space and light. The geological collections at the time of my visit were largely undergoing a change of installation so that I could not judge what their future appearance was to be. The zoölogical and ethnological collections were, however, quite fully installed. In these there was evidence of much thought and care in the installation, and many original and unique devices were to be seen. The cases are all of metal and glass, this being one of the few museums where this sort of case has been adopted. They are likewise largely uniform in type, being vertical floor cases about 10 feet high and perhaps 6 feet square. These are raised from the floor about 8 inches by legs. Such cases would usually be considered too large and deep for the proper display of small specimens, but by the use of a set of shelves narrowing toward the top, a pyramidal installation is secured, and even small specimens show up surprisingly well. The case interiors are cream white. Where wall cases are desired a case half the thickness, but of the same type, is employed. The top and often the sides of the case are fitted with ground glass. The doors are fastened by a vertical rod on the outside. The sashes of each door are so arranged as to have three long panes along the line of vision, with a row of shorter panes above and below. Thus the immediate field of ordinary vision is made large and glass is economized. The shelves are of glass and are supported on brackets of simple angle irons which are screwed to the wall plates with thumbscrews, or fit into a series of slots. Quite as often the brackets are fastened in front and project backward the width of the shelf, the evident purpose being to bring the contents of the case as near the eye as possible. The rows of slots are covered by thin strips of metal painted the color of the case interior, and thus the unsightly holes which usually accompany adjustable shelves are not to be seen. The metal and glass plan is followed throughout, even the trays used to hold the specimens, and the label holders, being of tin, while

wire is used for any special support. Thus there is nothing in the case or mounts capable of decay or of producing dust. Dust from the floors is further reduced to a minimum by having them covered with linoleum. The use of curtains in the cases is another unique feature. These are of the ordinary window-shade type and are let down in the middle, dividing the case into two parts and giving backgrounds. By the employment of curtains of different colors, pleasing effects are produced. The collection of corals and siliceous sponges, for example, is seen against a black curtain, the collection of jade against a red curtain, and a collection of Chinese pottery against a curtain of Oriental type. The division of the collections seemed to me likewise commendable in that it was well calculated to arouse the interest of the average visitor. Instead of the usual rows of genera and species arranged in synoptic order, the whole effect of which is first to impress the visitor with the fact that he knows nothing of that science, and second to convince him that he does not care to, there are small collections gathered around some common name or common idea from which study is led out to a wider field. Thus one case is devoted to a collection of doves, another to one of men-like apes, another to birds' nests, etc. There are provided in abundance tables, chairs, and books relating to the collections which invite to further study. Where space does not permit tables, a sloping shelf, fastened to one of the pillars or walls of the building, is used for a book support. Framed maps, colored to show the distribution of species, are also hung freely about. The zoölogical-ethnographical museum is open Sundays, Mondays, Thursdays, and holidays from 11 to 1, and Wednesdays and Saturdays from 1 to 3, free. It is closed Tuesdays.

Munich. — The important natural history collections in this city are to be seen in the building of the Academy of Science. This is a plain rectangular building of several stories, lighted by side windows. The mineralogical collection is to be found on the first floor, the paleontological on the second. The mineral collection is a choice and valuable one, the 4,500 specimens exhibited being but a tenth of the entire collection. The col-

lection is especially rich in rare and showy minerals of the Urals and the Tyrol. The collection is installed in vertical wall and "A" floor cases, the case interiors being colored maroon. The specimens are mounted on red or black walnut blocks. The meteorite cases are kept dry within by means of open dishes of sulphuric acid. For the deliquescent Stassfurt and other salts, a square jar, ground at the top to a bevel and fitted with a glass lid, is employed, and the specimens so installed show to much better advantage than in the usual museum jar. The collection of single crystals (a very large and choice collection) is shown in short "A" cases which have a steep slope and are fitted with narrow step shelves. By such an installation the eye of the observer can be brought close to the specimen, a most desirable arrangement for the study of objects so small. The crystals are mounted on wooden stands of the usual type. In the general collection index fingers are used freely on the specimens to point out individual crystals. The collection is divided into the terminological, systematic, genetic, and technological collections. In the terminological collection are illustrated structure, color, form, and luster of minerals, crystal form, growth of crystals, inclusions, crystal aggregates, and pseudomorphs. The systematic collection is arranged according to Groth's classification. The genetic series begins with the collection of meteorites, then follow rock-forming minerals and rocks, native salts, secondary minerals, and ores. The technological collection is intended to illustrate ores and minerals of economic importance with their products. There are shown in order ores of gold, mercury, silver, lead, tin, bismuth, antimony, zinc, iron, cobalt, nickel, manganese, and aluminium; then a series showing minerals used in the arts, such as materials for making glass, magnesite, strontianite, saltpetre, uraninite, chromite, borax, asphalt, ozocerite, asbestos, talc, mica, graphite, lithographic stone, Iceland spar, emery, tripoli, ornamental stones, and a series of gems showing the varieties of color exhibited by each species. Such a classification is well conceived and might be made most instructive if well executed, but, as is usual with such collections, insufficient care has been bestowed on the installation,

and many manufacturers' gifts have been introduced, so that the balance of the series is destroyed. A readable as well as exhaustive handbook, descriptive of the collection, is for sale by the attendant.

The paleontological collection is one of the largest in Europe. It is especially rich in mammals, reptiles, and fishes of North America. It is divided into three collections. In the first the fossils are arranged according to their biological order; in the second, according to their order in time; while the third is a local collection of fossils of Bavaria. Wall and floor cases of hard wood are used; the former of the usual type, the latter, desk cases with tops of a low slope. The smaller specimens are mounted on cardboard, the larger on bases of plaster or wooden blocks painted white. Most of the incomplete skeletons are restored, but a few, especially fishes and reptiles, are mounted upon wire frames, on which each bone has its proper place. While nothing especially novel in methods of installation was noted, the extent and variety of the material in this collection are such as to make it especially worthy of study. Among many specimens of great interest are a nearly complete skeleton of *Rhinoceros tichorinus*, found in a moraine near Ascham in Innthal; a complete skeleton of *Titanotherium trigonoceras*, and two skulls of the same genus; complete skeletons of the cave bear, of Rhinoceros and Hipparion, of Dinornis, and of many smaller species. Remains of an Ichthyosaurus from Boll, Würtemberg, show two young in the womb of their mother, thus giving proof of the viviparous character of the species. Other specimens show clearly the heterocercal tail. The fossils from the Solenhofen beds are superior in quality and quantity, some being remarkably vivid in their representation of ancient life. On one specimen may be seen tracks of a Limulus made for a short distance, and at the end the animal itself. Another specimen shows the trail of a mollusk made on the sand, ending with the mollusk itself.

Berlin: Naturhistorisches Museum. — The methods of installation employed in this museum have been so fully described by Dr. Hovey that little need be added. As in all other

museums which I saw constructed on the plan of galleries or halls around a central roofed court, the lighting is poor, so that much of the material cannot be seen satisfactorily. The rock collection, however, installed in flat floor cases, in a hall with side windows, is admirably lighted, and shows that such a combination may be satisfactorily used for obtaining good light. In the zoölogical halls, metal-framed cases, similar to those of the Dresden Museum, are employed. The same plan of group collections is also carried out, collections being exhibited which illustrate such features as varieties and differentiation of bone, skin, etc.

The Museum of the School of Mines adjoining has much important material and most of it well exhibited, but my time was too short to permit any study of its methods.

Zurich. — In the handsome Polytechnic Building are contained extensive geological and zoölogical collections, which are open to the public free one day in the week ; on other days admission is 50 centimes. The geological collection, built up chiefly by Professor Heim, is extensive and well cared for. The collections of minerals, rocks, and general geology are installed in floor cases of hard wood with sloping tops, no vertical wall cases being used. The collection here of greatest interest is that illustrating general geology. It is arranged upon a classification first proposed by Professor Heim, and is intended to illustrate the processes of formation, alteration, and decay which go on in the earth's crust. The classification, which is worth noting, is on the following page.

Each of these divisions is illustrated by specimens of the objects named, many of which are unique and striking. The proximity of the Alps has given an opportunity of which Professor Heim has made good use, for procuring the most vivid specimens. There are also shown, under each division, illustrations of the different phenomena as occurring in both recent and ancient time, as far as possible. Thus the collection as a whole gives a novel and effective presentation of the subject of general geology. The paleontological collection is large and well installed. Remains of the large quaternary mammals of

Rock Formation.	Action of Air.	Surfaces polished by wind-blown sands, coloring and splitting produced by sun's heat, loess, fulgurites, etc.
	Action of Water.	Chemical Erosion. Pittings on limestone, gypsum, etc.
		Chemical Alteration. Kaolin, clay, limonite, serpentine, etc.
		Chemical Deposition. *a.* Dendrites, amygdules, geodes, etc. *b.* In springs. Travertine, siliceous sinter. *c.* In lakes. Clay-iron-stone, oölitic limestone. *d.* In seas. Gypsum, anhydrite, salt, etc.
		Mechanical Deposition. River gravels, sand and silt; beach gravels, sand and silt; conglomerates, sandstones, etc.
		Strata Phenomena. Mud cracks, ripple marks, rain-prints, etc.
		Glacial Phenomena. Glaciated pebbles, moraine materials, scored and polished surfaces.
	Action of Life.	Erosion and Deposition by Plant Life. Rocks pitted by humus acids. Coal, peat, lignite, diatomaceous earth, petrified wood, etc.
		Erosion and Deposition by Animal Life. Rocks bored by mollusks. Animal remains, limestones, chalks, etc.
	Action of the Earth's Interior.	Volcanic products, ashes, lavas, tuffs, etc.
Rock Deformation.		Folded and crumpled rocks, stylolites, slickensides, etc.

South America form a feature. Of these only the actual bones are mounted, no attempt being made to restore the missing parts. While this method has the advantage of truthfulness, it cannot be said to produce a pleasing effect. To see, for example, scattered limb bones, vertebræ, and ribs of a Megatherium, mounted in the upright position of the animal, but with no head, gives a grotesque and ludicrous impression rather than one calculated to encourage scientific study.

Bern. — The Natural History Museum, built by A. Jahn in 1879–81, is a handsome stone building of three stories. The mineralogical and paleontological collections occupy the ground floor, the zoölogical the two upper floors. The alcove system of installation is employed and good lighting is secured. Both installation and labeling are neat and careful throughout, and one has a general sense of comfort and satisfaction in looking through the museum. Of greatest interest is the magnificent collection of crystals from the St. Gothard. One perfectly clear crystal of smoky quartz is 3½ feet long and 2 feet in diameter; another, doubly terminated, is 4 feet long. There are also large and showy groups of albite from the same region and of epidote from the Untersulzbachthal. Of interest in the paleontological collection are perfect skeletons of the cave bear and Irish elk. The museum is open free three hours a day on Tuesdays, Saturdays, and Sundays; on other days admission is one franc.

Neuchâtel. — The natural history collections exhibited in the Collége Latin are extensive and of permanent interest for their association with the memory of the great naturalist who founded them. The collection of fishes is unusually large, as is also the collection of marbles. The animal groups by Challande are also unique and attractive and embody an idea which one could wish to see more widely carried out. The installation is, however, in general antiquated, and while perhaps the best that funds will allow, furnishes an impressive illustration of the advance in museum methods since this collection was established. The cases employed are flat-topped floor cases and

vertical wall cases. They are painted white and the panes are of small size. The bases of the wall cases are so high that the specimens are almost out of sight. The halls are lighted by side windows. The museum is open to the public only six hours a week — four hours on Thursdays and two hours on Sundays.

Paris: Muséum d'Histoire Naturelle and *École des Mines.* — I have little to add to Dr. Hovey's admirable account of these museums. Nothing could better illustrate the advance which has taken place in museum methods in the last thirty years than to contrast the mineralogical museum in the Jardin des Plantes, having varied modes of installation, confused arrangement and cheaply framed cases, with the new paleontological museum having cases almost wholly of glass, and collections made up of consecutive series of exquisitely prepared and carefully labeled specimens. Similarly the advance which has been made in methods of collecting and in an understanding of what constitutes a "specimen" is well evinced by a comparison of the Haüy collection in the mineralogical museum, made up as it is of many insignificant fragments, with any decent mineral collection of to-day. Such contrasts show clearly how great are the possibilities of museum representation and the need of constant study for its improvement. Of single features, the notices to the public which take the place of the rude English "Hands off" or "Touch not" deserve imitation. They read as follows:

"Les pièces de cette galerie, étant très fragiles, sont confiées à la garde du public. On est prié de ne pas y toucher." (The specimens in this hall, being very fragile, are confided to the care of the public. It is requested that they be not handled.)

The museums of the Jardin des Plantes are open Sundays and Thursdays from 11 to 4, and by ticket on Tuesdays, Fridays, and Saturdays for the same hours. The École des Mines collections can be seen only Tuesdays, Thursdays, and Saturdays from 1 to 4.

London: British Museum (*Natural History*). — The character of this great museum and the methods of installation

employed are so generally known that any detailed description would be superfluous. The possibilities of a museum as an institution seem here to be as fully realized as is possible in the present state of museum knowledge. The well-lighted building, the extensive collections along all lines of natural history, the rich and careful installation, the perfect neatness, the complete labels, and the clear and comprehensive handbooks, all combine to show what a museum can do as a great storehouse of instruction.

Of single features the mount of jeweler's cotton for mineral specimens is worthy of note. It furnishes a neutral background and does not show dust. Instead of being described as forced into a groove, as Dr. Hovey has it, however, it should be said that the cotton is folded around a cardboard which fits the tray. This makes in one sense a groove, but is an easier mode of manipulation than the other. This mount is not used for all specimens where another background would give a better effect. Specimens of *flos ferri*, for instance, are mounted on purple velvet. Single gems are exhibited in shallow cups of celluloid. The crystal mounts are ebonized, conical bases tapering to a long slender rod, on the end of which the crystal is fastened. The rod, it may be said, is too long to suit the writer's taste. In labeling the species, if there are a number of specimens from different localities, only the locality is given on the specimen label; the species' name is shown on a label raised on a brass support and placed in the center of the group. The low installation employed for the mineral collection, while perhaps giving the best lighting to the specimens, to the writer's mind, does not make for the hall so attractive an appearance as could be obtained by the use of cases which would give a glimpse of their contents at a distance. The exhibition of specimens at the bottom of desk cases, at any rate, seems entirely useless. The meteorites are exhibited in pyramidal "A" cases fitted with a pyramidal series of shelves. The specimens are mounted on mahogany bases. The instructive collections introductory to the study of rocks, minerals, and meteorites deserve the highest praise. Wrought out in exquisite detail, the labels couched in clear and simple language, and with

every possible feature illustrated by specimens, the collections serve in the highest degree to show what such productions can do as mediums of instruction. In the paleontological collection vertical cases arranged on the alcove system are employed, interspersed with pyramidal "A" cases, in which the smaller specimens are shown. Every effort is put forth by the use of photographs, wash drawings, models, and descriptive labels to make the collections instructive. In connection with the vertebrate fossils there are even exhibited mounted skeletons of the modern elephant, rhinoceros, etc., in order to make clear by comparison the structure of the ancient mammals. Such an exhibit is most admirable but is possible, of course, only to museums of the largest size.

Museum of Practical Geology, Jermyn Street. — The plan of the museum building is that of tiers of galleries around a central roofed court. The lighting from above causes bad reflections in the flat cases around the court. The vertical cases are better lighted, but are narrow, necessitating upright installation, which is often inconvenient. The practical purposes of the museum have been kept in mind in the make-up of the collections, but, as seems often to be the case, the collections gathered on scientific lines are outgrowing those of economic interest. Among methods of installation I noted specially the mode of exhibiting maps. They are hung rolled on spring rollers from the edge of the gallery, whence a descending tassel permits the visitor to draw the map down for examination. Space is thus economized and the maps are better preserved. The large slabs of Ichthyosaur and Plesiosaur remains are framed and covered with glass, thus enhancing the appearance of the specimens and serving for their better preservation. An excellent handbook to the museum makes a study of the collections easy and interesting.

British Museum. — I have but a single note to quote of this museum, though much might be said of it in approval. Gems are displayed by being set in a frame placed in the outer part of a case with sloping sides, in the interior of which mirrors are

placed so as to reflect light *through* the stone. Thus the true color and luster of the stone are displayed as they could not be against an opaque background.

Oxford. — There is much valuable material in the geological collections of the University Museum, but it is largely hidden by the installation. The great series of Lyme-Regis specimens and much of the Prestwich collection, being piled in dark, deep wall cases and with few labels, are of little use to visitors. The minerals and rocks, now being installed in flat cases, show a beginning of better things, but the table cases used have a temporary look at best.

Bath. — The collections of the Moore Geological Museum owe their origin chiefly to the labors of Mr. Charles Moore. They are largely illustrative of the geology of the surrounding district, and of this field give an excellent representation. The display of Ichthyosaur and Plesiosaur remains is especially fine and probably unsurpassed outside of the British Museum. Here also are the remains of the diminutive *Microlestes*, which were found by carefully picking over three tons of clay. Wall cases and a gallery are the method of installation employed in one of the halls, while floor desk cases with tops of low slope occupy another. Most of the specimens are exhibited in pasteboard trays. The arrangement is primarily stratigraphical, and under each stratigraphical division zoölogical. The boundaries of each stratigraphical division are indicated by wide mahogany sticks, and those of the zoölogical groups by narrower black sticks. Figured specimens have green labels. A box of suggestive shape, with a suggestive slot and suggestively near the exit, is labeled "Contributions to the geological collection," thus making a not unreasonable request that those who derive instruction from well-arranged and well-cared-for collections shall contribute toward their maintenance.

Bristol. — The zoölogical collection is upon the ground floor, the geological upon the second floor of the building, modeled after the Doge's Palace in Venice, which constitutes the home

of the city library and museum. The model is hardly one worthy of imitation in museum architecture, especially on account of the outer arcade, which, though it doubtless adds to the beauty of the building, cuts off much of the light so essential to museum display. The geological collection is installed in floor desk cases. The fossils and minerals shown are chiefly local, but the region is one exceptionally rich in its representation of the strata of different ages. Type specimens are indicated by disks of yellow paper, figured specimens by green. Casts and maps are hung about to some extent. The minerals are grouped in an unusual fashion, the divisions being silica, silicates of alumina, lime minerals, and metallic ores with iron. This may be better than no grouping at all, but it cannot be said to teach anything of value. The installation as a whole shows lack of care, the case interiors being dusty and the specimens likewise. The labels are written with poor ink and many are hardly legible. Hence while there are many rare and showy specimens in the collection, and while the lighting of the upper floor at least is good, one is soon overcome by "the musty feeling," which, though once supposed to be a necessary concomitant of museums, now, happily, survives in but few.

Edinburgh. — The Museum of Science and Art combines the functions which its name indicates. The first-named function is apparently the more prominent, but the combination with the second (made to include industrial art) gives a pleasing character. It is one of the few museums which have succeeded with the experiment of evening opening. The evening attendance indeed is larger than that in the daytime. The hours of visiting are from 10 A.M. to 10 P.M., free on Mondays, Wednesdays, and Fridays. On other days admission is sixpence. The plan of the museum building seems unfortunate in some respects, as it is of the type which has been not unaptly termed "well construction," *i.e.*, tiers of galleries round a central roofed court. In such a building few visitors are likely to climb to the upper floors, and the lighting of many of the halls is necessarily poor. In the collections exhibited much attention is

paid to what is practical as well as scientific. There are many models shown, many illustrations of industrial processes, and many illustrations of the uses to which natural products can be put. There are many styles of cases employed, though perhaps not of choice. A combination of half of a flat and half of an upright case is much used for a wall case, though vertical wall cases are being gradually used to replace these. The latter cases are fitted with plate-glass shelves, which rest on *T*-shaped bars extending across the case and capable of being adjusted in height by fitting into a series of slots in wall plates which run vertically. The door jambs of the cases are fitted with velvet, against which the door is screwed by bolts at top and bottom, turned with a hand wrench, so as to effectually keep out dust. A pyramidal floor case, about 8 feet long, 2 feet wide, and 7 feet high (the base and legs being 2 feet high), is used in the hall of Scottish minerals. The form of the case cannot be said to be altogether attractive, but the lighting of the specimens is admirable. The shelves in this case are fastened to a central upright partition. The arrangement of the collection of fossils is wholly zoölogical. The mineral collection is classified on Dana's system. Several halls are devoted to a representation of the geology of Scotland, to illustrate which and the work of the Geological Survey, an exhaustive collection has been prepared. Maps of each district are shown, and in the adjoining cases are elaborate series of the rocks or fossils of the district. Photographs and transparencies, showing photomicrographs of the rocks, also add to the completeness of the exhibit. An extensive collection of the minerals of Scotland is also shown. An aquarium hall containing living fish attracts much popular attention.

General Conclusions. — If a museum building is on more than one floor or has its halls arranged in any other way than to favor a consecutive line of progress, the upper floors and side halls will not receive equal attention from visitors. If the building is of several stories, the windows should be high and face without; the plan of tiers of galleries around a central roofed court has many disadvantages.

Cases should be of uniform pattern (units) if possible. Their form will be determined by the lighting of the building. If this light is from above, vertical wall and floor cases should be used; if from the side, cases with flat or sloping tops. Metal framework for the cases has the advantages of tenuity and durability. All specimens should be cased, both for purposes of preservation and attractiveness. No pains or means should be spared to make installation rich, neat, and attractive; the most valuable material may be rendered practically worthless for museum purposes by poor installation, and *vice versa.*

The indefinite extension of synoptic or systematic collections is not a desirable effort for a people's museum. Such collections weary by their monotony and extent without teaching any adequate lesson. Group collections formed about some commonly understood idea are more attractive and instructive. To make such collections requires more time, thought, and care than to string out genera and species, but they are more than correspondingly valuable. The economic relations of things can, at least, be shown without much effort, but if this is done, care should be taken that classification is adhered to closely, and the collection kept well balanced.

Museums should cultivate home fields and aim to represent most fully the materials of their own districts in the same proportion and for the same reason that local interests and acquaintances are larger and more important than those at a distance. Thus the best collection of the fossils of the Paris basin should be, as it is, in Paris; of the minerals of Cornwall, in the British Museum; of Prussian amber, in the Berlin Museum.

As to form and style of labels, there can be little question of the superiority of the printed label, made as descriptive as possible. Case labels are very desirable, since they serve, like the headlines of a newspaper column, to show at a glance the character of the contents. In the Continental museums the need of labeling seems to be less generally recognized than in those of Great Britain and our own country. Specimens often have no label, and if they do have labels, they are usually simple statements of name and locality written on paper.

The Continental museums are also open for but remarkably few hours to the public. To illustrate this I have taken the trouble to quote the hours of a number in the preceding pages. Both of these peculiarities indicate that the old conception of a museum as a storehouse still predominates on the Continent. Yet the possibilities of a museum as a medium of public instruction, which are at present probably best understood and exemplified in the museums of Great Britain and America, are fast becoming appreciated on the Continent as well.

In conclusion, I have no better word than to quote a sentence spoken to me in conversation by Dr. Traquair, the able Keeper of the Natural History Collections of the Edinburgh Museum: "The first duty of a scientific museum is to teach science; of a curator, to preserve his specimens."

ON SOME CHANGES IN THE NAMES, GENERIC AND SPECIFIC, OF CERTAIN FOSSIL FISHES.

O. P. HAY.

THE writer desires to call the attention of paleontologists to the following changes, which it seems to be necessary to make in the nomenclature of certain fossil fishes. Nearly all these changes pertain to North American species or to genera represented in North America. While there may appear to be a considerable number of names which have been replaced by others, there are in reality few, when compared with the large number of species whose history has been studied. While it is to be regretted that old and well-known names have to be cast aside and new or unfamiliar ones substituted, the writer believes that it is better to reform nomenclature as soon as errors are discovered than, by repeating them, to make more difficult of accomplishment what must be done at some time by somebody.

In 1875[1] St. John and Worthen described a species of Cladodus which they called *C. carinatus*. The same name was employed in 1889 by Dr. Newberry[2] for an entirely distinct species. This requires, therefore, a new name, which may be *C. coniger*.

In 1894 Professor E. W. Claypole[3] described a supposed species of Cladodus which he designated as *C.* (*?*) *magnificus*. The name is, however, preoccupied, Tuomey having in 1858[4] described a *C. magnificus* from the state of Alabama. The former species may be named *C. claypolei*, in honor of the describer.

In 1891[5] Professor Cope described a fossil tooth which he called *Hybodus regularis*. However, the specific name is pre-

[1] *Geol. Surv. Ill.*, vol. vi, p. 279, Pl. IV, Figs. 6 and 7.

[2] *Palæoz. Fishes N. A.*, p. 103.

[3] *Amer. Geol.*, vol. xiv, p. 137, Pl. V.

[4] *Second Report Geol. Alabama*, p. 39.

[5] *Proc. U. S. Nat. Mus.*, vol. xiv, p. 448, Pl. XXVIII, Fig. 2.

occupied, having been applied to a Hybodus by Reuss in 1846.[1] The first-mentioned species may be renamed *H. copei*.

In 1866[2] Newberry and Worthen described, from the Burlington limestone of Iowa, a tooth which they called *Helodus compressus*. This species is now regarded as belonging to the genus Hybocladodus. In 1870[3] the same writers described another *Helodus compressus*, from the same horizon, in Illinois. In renaming the latter species I shall, by calling the fossil *H. wortheni*, endeavor to honor the director of one of the most creditably conducted of our state geological surveys.

The name Stemmatodus was applied in 1875[4] by St. John and Worthen to certain bodies which they regarded as teeth of shark-like animals, but which may be, as Mr. A. S. Woodward has suggested, dermal denticles. The name had, however, been employed by Heckel in 1856 for a genus of pycnodont fishes. Clearly the name, as employed by St. John and Worthen, must yield to some other term. I propose STEMMATIAS. The type will be *Stemmatias cheiriformis* St. John and Worthen. The recognized species are *S. bicristatus*, *S. bifurcatus*, *S. compactus*, *S. keokuk*, and *S. symmetricus*, all described by the authors referred to.

The name Goniodus was employed by Agassiz[5] in 1838 to designate a genus of sharks which had previously been called by Blainville Echinorhinus. Being therefore a synonym of Echinorhinus, it is not available as the name of any other genus. Nevertheless, it was in 1889 applied by Newberry[6] to certain pavement-like teeth from the Huron shales of Ohio. As a substitute for Dr. Newberry's name, Mr. S. A. Miller, in 1893,[7] proposed the name Xenodus. The type and only known species is *X. hertzeri* (Newberry).

In 1862[8] Morris and Roberts applied one of Agassiz's manu-

[1] *Verstein. böhm. Kreidef.*, pt. ii, p. 98.

[2] *Geol. Surv. Ill.*, vol. ii, p. 78, Pl. V, Fig. 1.

[3] *Geol. Surv. Ill.*, vol. iv, p. 360, Pl. III, Fig. 15.

[4] *Geol. Surv. Ill.*, vol. vi, p. 328.

[5] *Poissons Foss.*, vol. iii, p. 94.

[6] *Palæoz. Fishes N. A.*, p. 67.

[7] *N. A. Geol. Palæont.*, 1st App., p. 718.

[8] *Quar. Journn. Geol. Soc.*, vol. xviii, p. 101.

script names, Xystrodus, to a species which had in 1855 been described and figured as *Cochliodus striatus* by McCoy. The name therefore must date from 1862. But in 1860 Plieninger[1] described with some minuteness some Hybodont teeth, to which he gave the name *Xystrodus finitimus*. This earlier use of Xystrodus makes it impossible, or at least unwise, to use it in the sense given it by Morris and Roberts. The name PLATYXYSTRODUS may be used instead. The type will be as before, *P. striatus* (McCoy). The American species are *P. bellulus*, *P. imitatus*, *P. inconditus*, *P. simplex*, and *P. verus*, all by St. John and Worthen.

In 1883[2] Davis founded a genus of cochliodont sharks, to which he gave the name Tomodus. The name had, however, been used for other teeth in the same group by Trautschold in 1879.[3] It was, therefore, clearly preoccupied. Subsequently Trautschold renamed his genus Oxytomodus, but this in no way made Tomodus more available for Davis's genus. On this point see Mr. A. S. Woodward's remarks.[4] For the genus described by Davis, S. A. Miller[5] has proposed to substitute Icanodus. The type will, of course, be *I. convexus* (Davis). One American species belongs doubtfully to the genus. This is *I.* (*?*) *limitaris* (St. John and Worthen).

In 1843[6] H. von Meyer described, from the lower Miocene of Hesse Darmstadt, a species of ray which he called *Myliobatis serratus*. Leidy,[7] therefore, encroached on occupied territory when he named a fossil ray from the Eocene of New Jersey *M. serratus*. This may be called *M. leidyi*.

Two species of fossil Dipnoi require new names. In 1877[8] Professor Cope described remains which he denominated *Ctenodus gurleyanus*. In 1889 S. A. Miller[9] modified the specific

[1] *Neues Jahrb. Min.*, p. 695.
[2] *Trans. Roy. Dublin Soc.*, [2], vol. i, p. 446.
[3] *Nouv. Mém. Soc. Imp. Nat. Moscou*, vol. xiv, p. 55.
[4] *Cat. Foss. Fishes*, vol. i, p. 191.
[5] *N. A. Geol. Palæont.*, 1st App., p. 716.
[6] *Neues Jahrb. Min.*, p. 703.
[7] *Proc. Acad. Nat. Sci. Phila.*, p. 395.
[8] *Proc. Amer. Philos. Soc.*, vol. xvii, p. 54.
[9] *Palæoz. Foss. N. A.*, p. 593.

name to *gurleianus.* In 1891[1] Mr. Woodward referred the species to Sagenodus. In a posthumous paper, published in 1897,[2] Cope described as a new species another *Sagenodus gurleianus.* This evidently requires a new name. I propose *S. textilis.*

In 1889[3] Newberry described a dipnoan tooth, which he called *Dipterus* (*Ctenodus*) *radiatus.* But the name is preoccupied. Eichwald in 1844[4] described a *C. radiatus*, and in 1858[5] this was referred by Pander to the genus Dipterus. Newberry's species may be called *D. contraversus.*

The genera which have been known as Rhizodus and Megalichthys are particularly exasperating cases from the point of view of nomenclature, and I regret that it appears necessary to deal with them. Megalichthys is credited to Agassiz and Hibbert, and was apparently first proposed in a paper published by Hibbert in 1836.[6] The only species there described is *M. hibberti*, although another, *M. falcatus*, is mentioned. The age of the enclosing rocks is Lower Carboniferous. The genus and species are clearly based on the materials collected at Burdiehouse, near Edinburgh, although the descriptions are clouded somewhat by Agassiz's knowledge of the remains of a different fish found in the museum at Leeds. This was derived from the coal measures, and Agassiz regarded it as identical with the Scottish specimens. When in 1844[7] Agassiz came to describe *M. hibberti*, he based his description on the Leeds specimens; and since that time the name has adhered to the coal-measures species. It is evident that the name must be restored to the Scottish types. The latter were figured by Buckland in 1837,[8] partly under the name of *M. hibberti* and partly as *Holoptychus hibberti*. Owen in 1841[9] imposed on these Scottish specimens

[1] *Cat. Foss. Fishes*, vol. ii, p. 261.

[2] *Proc. Amer. Philos. Soc.*, vol. xxxvi, p. 82, Pl. I, Fig. 9.

[3] *Palæoz. Fishes N. A.*, p. 119, Pl. XXVII, Fig. 33.

[4] *Bull. Soc. Imp. Nat. Moscou*, vol. xvii, p. 827.

[5] *Ctenopdipt. Devon. Syst.*, p. 22.

[6] *Trans. Roy. Soc. Edinb.*, vol. viii, pp. 169–282, Pls. V–XII.

[7] *Poissons Foss.*, vol. ii, pt. ii, p. 89, Pls. LXIII, LXIV.

[8] *Geol. and Mineral.*, ed. 2, vol. ii, p. 43, Pl. XXVII.

[9] *Odontography*, vol. i, p. 75.

the name *Rhizodus hibberti*, and the name has clung to them ever since.

Evidently all the species which have been marshalled under the name Rhizodus must be placed under Megalichthys of Agassiz and Hibbert. The British species are *M. hibberti* Agassiz and Hibbert and *M. ornatus* Traquair. The American species are *M. augustus* (Newberry), *M. incurvus* (Newberry), *M. lancifer* (Newberry), and *M. occidentalis* (Newberry and Worthen).

What, then, must be done with the species which have been masquerading under Megalichthys of Agassiz (1844)? The first generic name applied to any of this group of species after 1844 was Centrodus, given by McCoy[1] (1848). This, however, is preoccupied, having been applied to some fossil elasmobranch teeth by Giebel in 1847.[2] The next name in order of time is apparently Parabatrachus, proposed by R. Owen in 1853.[3] This was given to a portion of the skull of an animal, which Owen regarded as batrachian, near Archegosaurus, but which is now identified with Megalichthys of Agassiz (1844). The type species is *P. colei*, but this is now regarded as identical with *M. hibberti* Agassiz (1844). It may not at first thought be pleasing to our ideas of propriety to accept this name for a fish, but we must remember that one of our common marine fishes bore for a long time the generic name Batrachus.

What specific name is the species described by Agassiz in 1844 to bear? It cannot be *hibberti*, because the name *M. hibberti* had in 1836 been applied to another species. This will furnish some compensation for the disadvantages resulting from changes, because the name has been a source of confusion, and because Hibbert had nothing to do with it, except to speak of it incidentally. The earliest name given in the synonomy of the species by Mr. Woodward[4] is one of Agassiz's names, *maxillaris*.[5] If our conclusions, then, are correct, the fish which

[1] *Ann. Mag. Nat. Hist.*, [2], vol. ii, p. 3.
[2] *Fauna Vorwelt; Fische*, p. 344.
[3] *Quar. Journ. Geol. Soc.*, vol. ix, p. 67.
[4] *Cat. Foss. Fishes*, vol. ii, p. 378.
[5] *Poissons Foss.*, vol. ii, pt. ii, p. 96.

in all recent works has been known as *M. hibberti* becomes *Parabatrachus maxillaris* Agassiz. Other British species are *P. coccolepis* (Young), *P. intermedius* (Woodward), *P. laticeps* (Traq.), *P. pygmæus* (Traq.), and *P. lævis* (Traq.). The American species are *P. nitidus* (Cope), *P. ciceronius* (Cope), and *P. macropomus* (Cope). *P. maxillaris* possibly also occurs in this country. *P. nitens* (A. Fritsch) occurs in Bohemia.

Certain well-known genera and one species of pycnodont fishes bear names that are not tenable.

In 1872[1] Dr. Leidy described a pycnodont, which he named *Pycnodus faba*. But already in 1847[2] H. von Meyer had given the same name to remains from the Eocene of Germany. Leidy's species may then be given the name *P. phaseolus*, in allusion to the resemblance of the larger teeth to the pods of the wild bean, Phaseolus.

As Mr. A. S. Woodward tells us,[3] the generic name Microdon, which has been used so long for a genus of pycnodonts, being proposed by Agassiz in 1833,[4] had been used previously in entomology by Meigen in 1803. It is, I am informed, now in current use as a genus of Diptera. If this name may be employed in both ichthyology and in entomology, its seems reasonable that the conchologists may be allowed to resurrect Conrad's Microdon; and we might then discuss the question whether the fish Microdon subsisted wholly on such mollusks as Microdon, or occasionally varied its diet by adding such Diptera as Microdon. I regard it as subversive of the purposes of scientific nomenclature to perpetuate the use of such preoccupied names. As I find no synonym of Agassiz's Microdon which may take its place, it becomes necessary to propose a new name. This is Polypsephis, from πολυψηφῖς, *with many pebbles*, in allusion to the numerous rounded teeth. No American species are at present referred to this genus.

Mesodon of Wagner (1851)[5] is not available in ichthyology,

[1] *Proc. Acad. Nat. Sci. Phila.*, p. 163.

[2] *Neues Jahrb. Min.*, p. 186.

[3] *Cat. Foss. Fishes*, vol. iii, p. 221.

[4] *Poissons Foss.*, vol. ii, pt. i, p. 16.

[5] *Abhandl. k. bay. Akad. Wiss., math.-phys. Cl.*, vol. vi, p. 56.

having been used by Rafinesque for a genus of mollusks in 1819. According to Mr. Woodward,[1] Typodus of Quenstedt (1858) is probably identical with Mesodon of Wagner. It is therefore accepted provisionally as the generic name of those pycnodont fishes which have hitherto been called Mesodon. The American species will be *T. abrasus* (Cragin), *T. dumblei* (Cope), and *T. diastematicus* (Cope).

The genus Catopterus Redfield cannot be retained in the sense now given it. It was proposed by J. H. Redfield in the year 1837.[2] In his paper he states that the name had been used by Agassiz originally for a very different fish ; but since Agassiz's Catopterus had been reduced to synonomy, Redfield evidently thought that he was at liberty to use it again. Any one who has had experience in systematic work has soon learned how much confusion this practice produces. Few naturalists would now, I think, defend this practice, even though they may accept such preoccupied names on account of their long standing. Agassiz's Catopterus is a synonym of Dipterus. For the species which have been included under Catopterus of Redfield, no other generic name has, so far as I know, been proposed. I therefore offer the new name REDFIELDIUS, in honor of William C. Redfield and John Howard Redfield, father and son, two of the early students of American palæichthyology. The type of the genus will be, as before, *R. gracilis* (Redfield). The other recognized species are *R. anguilliformis*, *R. minor*, *R. ornatus*, *R. parvulus*, and *R. redfieldi*. The change of name of the genus will abolish Catopteridæ as the name of the family. It may be replaced by Dictyopygidæ from Dictyopyge, the other genus of the family.

The name Eugnathus, by which a well-known group of fossil fishes has long been known, must give way to some other term. Eugnathus, as a name for fishes, was first employed by Agassiz in 1844,[3] the type species being *E. orthostomus*. However, the name had been used as early as 1834 by Schönherr for a genus

[1] *Cat. Foss. Fishes*, vol. iii, pp. 199, 215.

[2] *Ann. Lyc. Nat. Hist. N. Y.*, vol. iv, p. 39.

[3] *Poissons Foss.*, vol. ii, pt. ii, p. 97.

of curculionid beetles, and is in current use. So far as I can determine, the next name in succession is J. W. Davis's Lissolepis[1]; but this is preoccupied, having been imposed on a genus of lizards by Peters in 1872. The next name in order seems to be Zittel's Isopholis.[2] Zittel does not indicate the type of his genus; and the first species named under it, *crenulatus*, is not, according to Mr. Woodward,[3] a member even of the same suborder. The position of *I. münsteri*, the species figured, is also doubtful. However, these may be removed and the genus allowed to rest on the species remaining; and as type of Isopholis we may take the species described by Agassiz as *Pholedophorus longiserratus*, it being also one of the species included by Zittel in his Isopholis. The family name Isopholidæ may be derived from this genus.

In 1849,[4] and again in 1852,[5] Roemer defined from manuscript of Debey a new genus of fishes, which he called Ancistrodon. The generic name cannot in my opinion stand, being practically preoccupied by Agkistrodon, proposed in 1799 by Palisot de Beauvois.[6] Although differing in form, the two names are merely different ways of transliterating the same Greek words. Furthermore, many authors have written the ophidian generic name Ancistrodon. Professor S. F. Baird so spelled the word as far back as 1859. Unless we are prepared to adopt the recently suggested rule to regard as eligible all names which differ by a single letter, no matter how that difference has been produced, we must, I think, abandon Ancistrodon as a generic name in ichthyology. In its place I offer the name Grypodon, from γρῦπος, *hooked*, and ὀδών, *tooth*. The type of the genus is *G. texanus* Dames. Other species described[7] are *G. mosensis* Dames, *G. lybicus* Dames, *G. armatus* Gerv., *G. vicentinus* Dames.

I have already referred to S. A. Miller's First Appendix to

[1] *Ann. Mag. Nat. Hist.* (1884), vol. xiii, p. 448.

[2] *Handb. Palæont.*, vol. iii, p. 216.

[3] *Cat. Foss. Fishes*, vol. iii, p. 463.

[4] *Texas*, etc., p. 419.

[5] *Kreidebild. von Texas*, p. 30.

[6] *Trans. Amer. Philos. Soc.*, vol. iv, p. 381.

[7] Dames, W. *Zeitschr. deutsch. geol. Ges.*, vol. xxxv (1883), pp. 656–670.

his *North American Geology and Palæontology.* This Appendix was issued about the beginning of the year 1893, and contains a number of new names which were proposed as substitutes for preoccupied generic names of fishes. These are, omitting those already mentioned, as follows: Eczematolepis for Acantholepis Newberry; Tegeolepis for Actinophorus Newberry; Ponerichthys for Dinichthys Newberry; Dissodus for Diplodus Agassiz; Haplolepis for Eurylepis Newberry; Gamphacanthus for Heteracanthus Newberry; Lispognathus for Liognathus Newberry; Millerichthys for Pterichthys Agassiz; Oestophorus for Sphenophorus Newberry.

Most of these names proposed by Miller must, I think, be accepted, but not all. For Diplodus, which is manifestly preoccupied, Dissodus is not required, since there is a number of available synonyms of Diplodus. Of these Dittodus (Owen[1]) is probably to be preferred. In proposing Ponerichthys to replace Dinichthys Miller labored under a misapprehension. The genus Dinichthys was founded by Dr. Newberry in 1868,[2] being based on the species *D. herzeri.* In the same year Prof. C. H. Hitchcock[3] published an account of Dinichthys, but it was a report of Newberry's discovery, and the author made no pretense of claiming credit for the name. In any case, there is no demand for a new name since the Dinichthys of both writers was based on the same species.

As regards Pterichthys, there is no getting around the fact that the name as employed by Agassiz in 1844 is preoccupied. Swainson in 1839[4] first applied the name to a group of recent fishes, defining it and referring to it a number of recognized species. But Millerichthys, proposed in honor of Hugh Miller, is superfluous, as well as devoid of euphony. Peter Bleeker as long ago as 1859[5] had perceived that the Pterichthys of Agassiz was antedated, and by a lucky stroke of his pen had parenthetically proposed Pterichthyodes in its place. This

[1] See A. S. Woodward's *Cat. Foss. Fishes*, part i, p. 2.

[2] *Proc. Amer. Assoc. Adv. Sci.*, 16th meeting, p. 146.

[3] *Geolog. Mag.*, [1], vol. v, p. 184.

[4] *Nat. Hist. and Class. Fishes*, etc., ii, p. 265.

[5] *Enum. Spec. Pisc. Arch. Ind.*, Tentamen, p. 11.

name does not appear anywhere else, so far as I know, and I am indebted for my knowledge of it to Dr. T. N. Gill, who is so thoroughly informed on all that pertains to the classification of fishes.

For information regarding the status of the generic names mentioned in this paper as being employed in entomology, I am indebted to Messrs. Ashmead and Schwarz of the department of entomology in the U. S. National Museum.

THE UTILITY OF PHOSPHORESCENCE IN DEEP-SEA ANIMALS.

C. C. NUTTING.

In a paper entitled "The Color of Deep-Sea Animals," read at the last meeting of the Iowa Academy of Sciences, I brought together a number of facts tending to show that the actual quantity of phosphorescent light emitted by animals of the deep sea was very considerable; so great, indeed, as to supply over definite areas of the sea bottom a sufficient illumination to render visible the colors of the animals themselves. If this be true, we have an explanation of the colors themselves along the same lines as are adopted in discussions of animal coloration in general. Coloration is practically meaningless in the absence of sufficient light to make colors visible. Having explained the colors of deep-sea forms by demonstrating a light in the depths sufficient to render visible the prevailing bright colors, *i.e.*, reds, yellows, and greens, of the animal inhabitants, it is interesting, and may be profitable, to seek an answer to the question: "Of what profit is the phosphorescence to its possessors?"

I must confess to having scant sympathy with those naturalists who delight in demonstrating, to themselves at least, the falsity of the good old Darwinian dictum that "every character possessed by an animal is of use to the species, or was of use to its ancestors." Men nowadays are willing to assert boldly that certain characters of animals are "meaningless."

For instance, Beddard, in his *Animal Coloration*, p. 37, says: "The inevitable conclusion, therefore, from these facts appears to be that the brilliant and varied colorations of deep-sea animals are totally devoid of meaning. They cannot be of advantage for protective purposes, or as warning colors, for the single and sufficient reason that they are invisible."

Again, one of our own writers, Dr. Walter Faxon, in his work on the stalk-eyed Crustacea secured by the *Albatross* (p. 253), says, in reference to the red color of the deep-sea Crustacea: "This color, then, is to be regarded as entirely useless to its possessor," and concludes that because certain species turn red when placed in the dark, he can explain the red color of deep-sea forms as a purely physical result of their environment.

Now I, for one, am unwilling to surrender the original Darwinian proposition. Of course there are many things yet to be explained, or even inexplicable with our present knowledge. But this does not justify the unqualified use of such terms as "meaningless" and "useless."

It is the purpose of this paper to explain cases in which phosphorescent light is emitted by animals, in terms of its use to the animals themselves.

To this end we can conveniently divide the inhabitants of deep water into *free-swimming* and *fixed* forms. In the former class would be all of the fishes, nearly all of the Crustacea, most Mollusca, Vermes, and Echinodermata, part of the Cœlenterata, and most of the Protozoa.

It will also simplify matters to remember that practically all deep-sea forms live on animal food. Among the fishes are several, allied to Lophius and Antennarius, which are provided with a bait said to be luminous, which serves to attract the prey. Others are luminous along the lateral line in definite spots. The utility in this case is not certainly known, but two suggestions may be made, one to the effect that the light attracts the mate and thus serves the purpose of *attractive coloration;* the other that it attracts the prey and serves the purpose of *alluring coloration.*

A very large number of crustaceans are phosphorescent, often brilliantly so. Many of these have large eyes, and are particularly active in movement and voracious in appetite. They feed on minute organisms, for the most part, and it can hardly be doubted that they often use their phosphorescent powers for the purpose of illuminating their surroundings and revealing their prey. Here again it is probable that the

strangely attractive power of light serves a definite purpose in the life economy of the animal.

Among the Mollusca we have few instances, so far as I know, of phosphorescent organs. Lamellibranchs, however, are largely vegetative, impassive animals. The Gastropoda are more active, but still slow in movement compared with most animals. Among the Cephalopoda are a number of highly specialized and swift-moving forms, and here, if anywhere among mollusks, we should expect to find phosphorescent organs. At the Detroit meeting of the American Association, Professor William E. Hoyle, of England, read an exceedingly interesting paper on certain organs possessed by Cephalopoda secured by the *Challenger*. These organs were regarded as phosphorescent by Professor Hoyle, who described a highly specialized apparatus designed to reflect light from the phosphorescent bodies downward to the bottom over which the animal passed. In this case it appears that there is not only a light, but also a reflector, an efficient "bull's-eye" lantern for use in hunting through the abyssal darkness. Among Vermes are many forms possessing a high degree of light-emitting power, which may be either attractive, alluring, or directive in function, and thus of direct advantage to its possessors.

Most of the echinoderms, although not truly fixed, are not capable of rapid locomotion. Perhaps the most active animals of this group are the serpent stars, some of which are able not only to crawl rapidly, but actually to swim with considerable facility. It is therefore interesting to note that the only phosphorescent echinoderm that I can find any account of belongs to the Ophiuridæ, and is described by Agassiz as "exceedingly phosphorescent, emitting at the joints along the whole length of its arms a bright, bluish-green light." Its utility can only be conjectured. If, as in the case with many of its allies, its life is spent crawling among the branches of phosphorescent gorgonians, the protection thus secured would certainly be advantageous.

Coming now to the Cœlenterata, we find many notably phosphorescent organisms. The ctenophores and medusæ comprise the greater part of the free-swimming members of this

subkingdom, and it is among these that we encounter amazing displays of the "living light." The most brilliant exhibition of phosphorescence that I have seen was caused by immense numbers of ctenophores in Bahia Honda, Cuba. The animals kept in a compact body and produced a maze of intertwining circles of vivid light. These animals have so-called "eye-spots" and seem to be able to distinguish light. The phosphorescence may serve to keep them together, and thus effect the same end as "directive coloration" among vertebrates and insects.

It is worth noting that blind species of groups normally possessed of eyes are seldom if ever phosphorescent, a fact that seems further to enforce the idea that phosphorescence is used in connection with the power of vision, and probably serves as an aid thereto.

Although Noctiluca and other allied phosphorescent Protozoa are more properly pelagic than deep-sea forms, they may occur at considerable depths, and thus come within the province of this discussion. These differ from the organisms hitherto mentioned in that they have no recognized organs of sight, and, further, in their extreme simplicity of organization. Like most if not all Protozoa, they occur in enormous swarms and have some means of keeping together, as is necessary in the case of all forms that conjugate as a preliminary to reproduction, as do the ones under discussion. They are propelled by flagella and appear to control their own movements. At first thought one is at a loss to explain the phosphorescence of these eyeless free-swimming forms, but a little reflection will show a probable explanation. Although eyeless, many Protozoa have been proved to be sensitive to light, both natural and artificial. Any one who has worked with these lowly forms has noticed that each species has a preference for either the light or the dark side of the jar in which it is confined. Indeed it is practically certain that sensibility to light is a fundamental property of simple protoplasm. This being true, it is easy to conceive of the phosphorescence of Noctiluca and its allies as *directive* in function, thus aiding them in finding each other for the purpose of conjugation and the perpetuation of their kind.

This same explanation may be applied to many of the phos-

phorescent medusæ. In the subtropical Atlantic hundreds of square miles of the surface are thickly strewn with a medusa, *Linerges mercurius*, which glows like a living coal at night. This species has eight marginal sense-bodies, and the phosphorescence may well serve as a directive contrivance, aiding in the perpetuation of the species.

In general, it may be said that the phosphorescent powers possessed by free-swimming deep-sea forms can be accounted for in very much the same manner as their coloration, and serve much the same purposes as protective, aggressive, alluring, and directive colorations.

We now come to a consideration of the uses of phosphorescent powers in the second class of animals indicated at the beginning of this paper, namely, the *fixed forms*.

Most of the phosphorescent organisms in this group belong to the subkingdom Cœlenterata. Among the Actinozoa the Pennatulidæ are mentioned by several writers as being especially brilliant in their flashes of light. The gorgonians are also often phosphorescent, and Agassiz says: "Species living beyond 100 fathoms may dwell in total darkness, and be illuminated at times merely by the movements of abyssal fishes through the forests of phosphorescent alcyonarians."

Many authors have noted the light-emitting powers of numerous hydroids. These occur in great quantities over certain areas of the sea bottom, and must add considerably to the sum total of deep-sea light.

It may, I think, be said that in general the fixed marine forms are not behind their free-swimming allies in either the quality or quantity of their light-producing powers.

The question now before us is: "Of what use is this power to its fixed and sightless possessors?"

Perhaps the most generally accepted opinion is that suggested by Verrill, who regards the phosphorescence as *protective* in function. Most Cœlenterata, he argues, are possessed of nematocysts. Fishes are known in some instances to eat the polyps of colonial forms, and they might come to associate the phosphorescence with the nettling cells, and thereafter avoid those forms showing the danger signal.

It is somewhat unfortunate for this argument that few if any of the fixed Cœlenterata that are remarkable for their phosphorescence possess nematocysts that are likely to be regarded by a hungry fish as at all formidable. The Gorgonidæ, Antipathidæ, Alcyonidæ, and Pennatulidæ, all notably phosphorescent, are almost if not quite destitute of nematocysts. As for the Hydroida, there is only one known species, so far as I can learn, whose nematocysts can be felt at all by the human skin. Millepora, if it be a hydroid, is of course another exception.

Neither is it likely that the phosphorescence of these fixed forms serves the same purpose as attractive coloration. Although the Cœlenterata are, in general, bisexual, the spermatozoa are shed into the water to find their way as best they can to the female element in other colonies. So far as I know, the colonies of both sexes are phosphorescent, but the light, in the hydroids at least, seems to be mainly confined to the polyps, or nonsexual "persons," excepting in those forms that produce medusæ.

Having shown that the phosphorescence of fixed forms cannot be regarded as protective, and that it does not appear to be for the purpose of attracting or guiding the sexes in coming together, we turn to a third and more promising explanation.

The food of the fixed Cœlenterata consists mainly of either Crustacea of the smaller sorts, their embryos, the Protozoa, or the unicellular plants, such as diatoms.

Most of the minute Crustacea have effective eyes, and it has been repeatedly demonstrated that they are attracted by light, both artificial and natural. Crustacean embryos usually have eyes that are very large in proportion. In many cases these, too, are attracted by light. Although I know of no direct experiments being made with phosphorescent light, it is reasonable to suppose that it would affect them in a like manner, although probably in a less degree. If this is true, the phosphorescent powers of the fixed Cœlenterata would cause the small crustaceans, and more surely their embryos, to congregate near the illuminated areas, and thus be captured. This is on the same principle that many fishes, birds, and even mammals

are secured by what is known as "fire hunting." In this same way the entomologist reaps a harvest by the aid of the electric light. The process would be analogous, perhaps, to what is known as "alluring coloration," and its function in decoying prey. The phosphorescence would thus be of direct utility to the fixed cœlenterates in securing crustacean food.

We may, I think, still further extend the application of this idea so as to include the attraction of Protozoa and even diatoms. As already remarked, both of these groups of organisms contain many species that are strongly attracted by light, which appears to act as a direct stimulus to both unicellular animals and plants by virtue of its well-known effect on protoplasm itself.

We thus see that all of the more important organisms upon which fixed cœlenterates feed are likely to be attracted by light, and it is reasonable to assume that phosphorescent light affects them in this manner.

This, then, is the hypothetical explanation by which we may explain the possession of phosphorescent light by so many fixed Cœlenterata on the old Darwinian principle of direct benefit to its possessors, the benefit being the aid rendered in securing food.

A NEW HYDROID FROM LONG ISLAND SOUND.

CHAS. P. SIGERFOOS.

DURING the summer of 1898, while enjoying the facilities of the seaside laboratory of the Brooklyn Institute of Arts and Sciences at Coldspring Harbor, Long Island, the writer found a hydroid which possesses special interest on account of the peculiar features which characterize it. The specimens collected last year were obtained on a single day, and a description has been delayed that new data might be added through wider observations during the present summer.

Early in August, 1898, while exploring the east end of Lloyd's Harbor, a part of Huntington Bay, small flocculent masses of different colors were observed in considerable numbers on the eelgrass which forms a dense growth on the bottom. Again this year the same locality was visited several times from July 8 to August 16, and each time numerous specimens were collected. The small cove in which they were found is a few acres in extent and well sheltered from high winds, so that the surface is usually smooth. During high tide the water may be ten feet deep, but at low tide the grass forms more or less of a mat upon the bottom.

Casually examined, the flocculent masses appeared quite similar to the well-known hydroid Hydractinia, found abundantly on our Atlantic coast, including Long Island Sound. But examined more carefully, it was found that the inhabitants of the shells on which the hydroid lives are living snails (*Ilyanassa obsoleta*), and not the hermit crabs with which Hydractinia is most frequently associated. Also, that the make-up of the colony as a whole and the character of the individuals are different from those of Hydractinia.

A general view of a female colony, natural size, is shown in Fig. 1, in which the snail is represented as moving slowly over a blade of eelgrass. Though the colonies are rather small, the

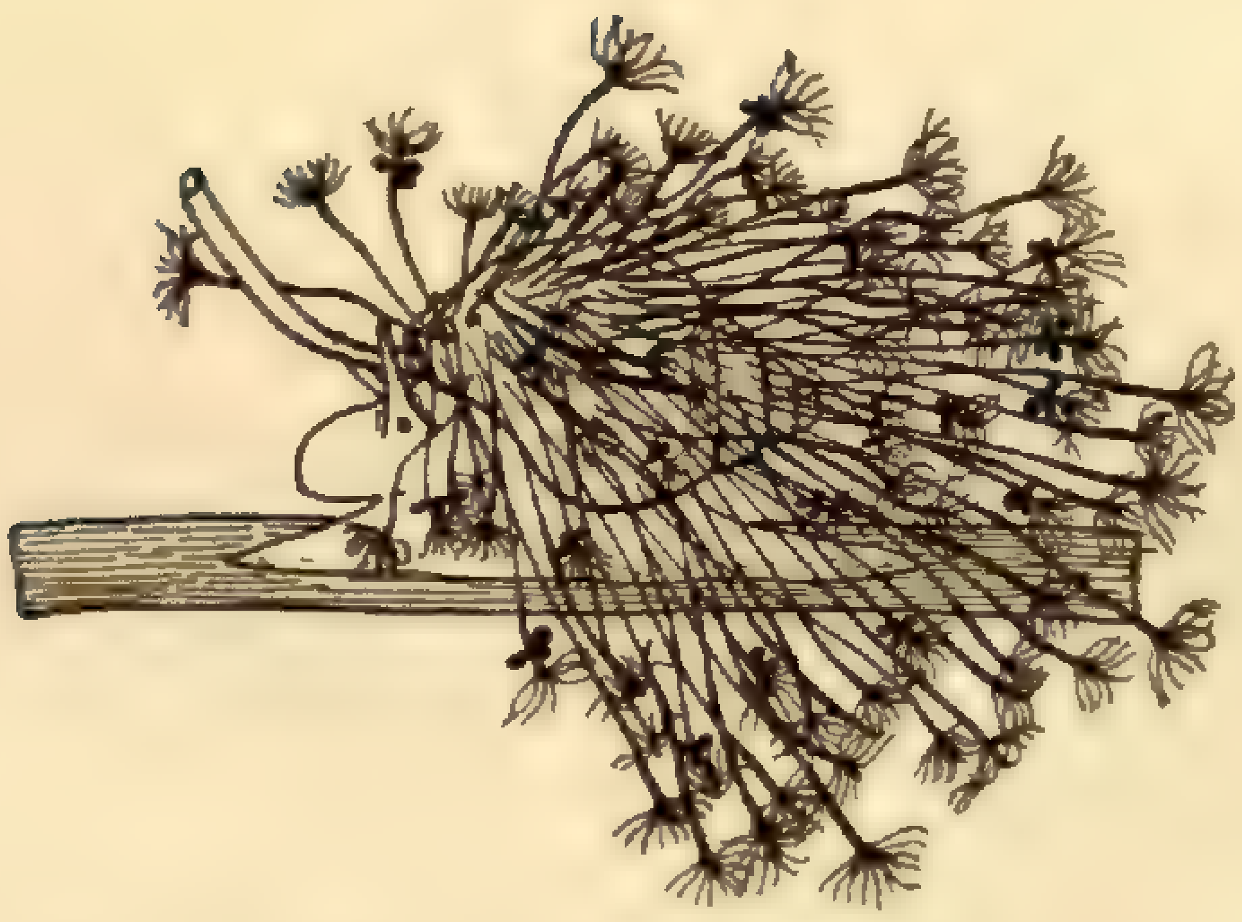


FIG. 1. — Colony of *Stylactis Hooperii* on the shell of a living *Ilyanassa obsoleta*, which is represented as crawling over a blade of eelgrass. Natural size.

larger ones may contain as many as two or three hundred individuals. In a figure it is not feasible to represent more than a third of those found in a dense colony.

The colony includes two, and only two, kinds of individuals, the nutritive and the reproductive. The protective spiral zoöids found in Hydractinia are not present.

A small part of a colony, enlarged six diameters, is represented in Fig. 2. The hydranths or individuals are sessile, arising directly from the complicated system of tubes, the hydrorhiza, which closely invest the surface of the snail shell. These tubes (Figs. 2 and 3) form a network lying in a general way in one plane. From this network arise the hydranths and also a few small spines (sp., Figs. 2 and 3), which seem to be homologous with those found in such forms as Hydractinia and Podocoryne. The tubes differ from those of these two genera, however, in not having the continuous layer of flesh (the cœnosarc) which covers the superficial surface of

FIG. 2. — Part of a colony magnified six diameters. (1) large nutritive hydranth fully expanded; (2) same slightly contracted; (3) same fully contracted; (4) large reproductive hydranth fully expanded; (5) smaller reproductive hydranth, slightly contracted; *Hr.*, tubes of hydrorhiza; *sp.*, spines.

the hydrorhiza in Hydractinia and Podocoryne. But there is a thick cushion of diatoms, simple algæ, and other detritus which forms a mat over the surface of the shell and around the attached ends of the hydranths. It seems to collect because the colonies are not tumbled about as in Hydractinia. The spines do not project beyond the surface of the mat and seem not to be efficient structures in protecting the colony. They are probably vestigial.

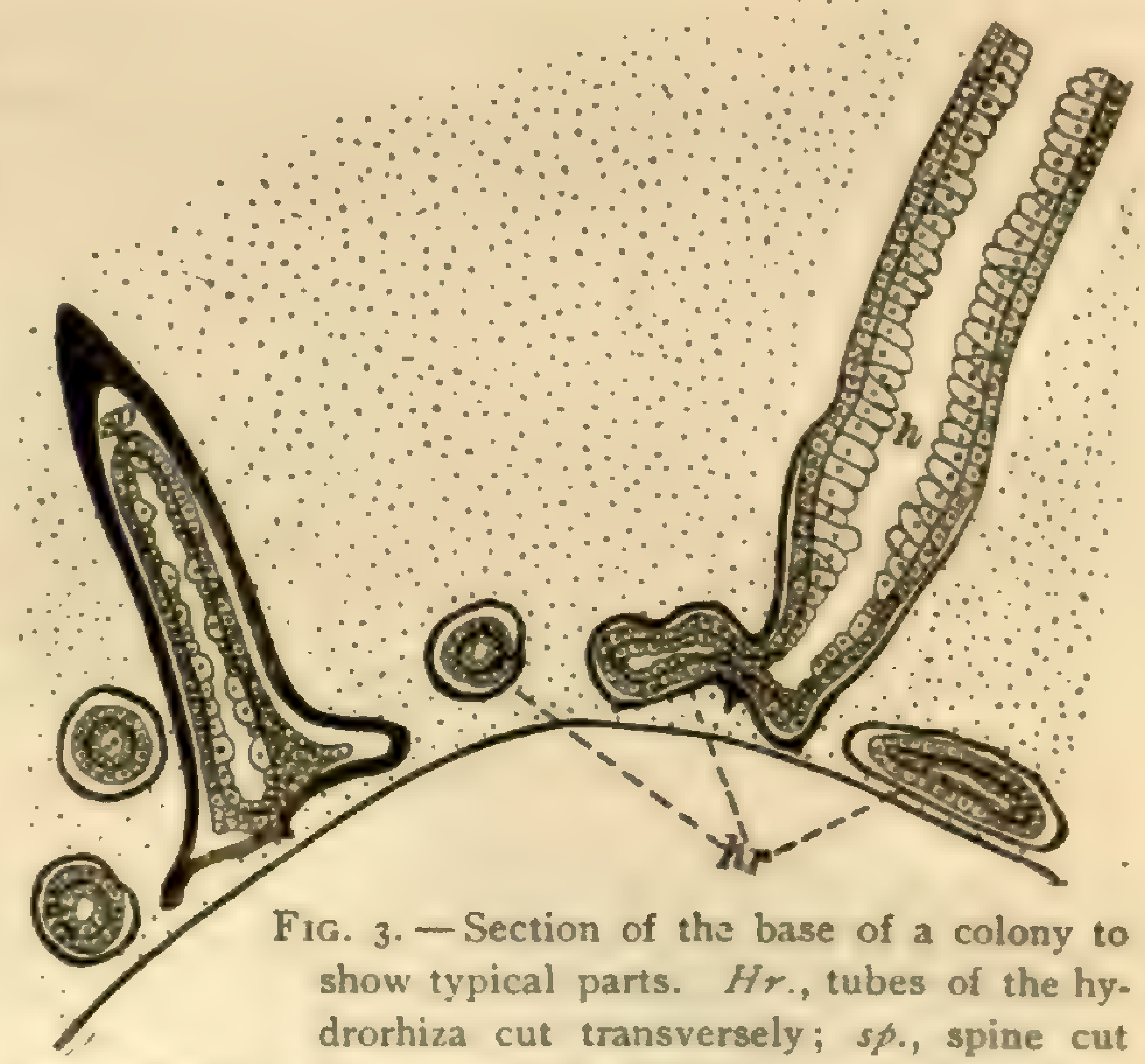


FIG. 3.— Section of the base of a colony to show typical parts. *Hr.*, tubes of the hydrorhiza cut transversely; *sp.*, spine cut longitudinally; *h.*, proximal part of a hydranth arising from a tube of the hydrorhiza. The dotted area represents the diatoms and other detritus which surround the base of the hydranths. × 30.

As stated above, there are but two kinds of hydranths, the nutritive and reproductive. They are present in approximately equal numbers, and uniformly distributed among each other throughout the colony. Both were found in all stages of development. I have no evidence that either ever becomes transformed into the other. As in other hydroids, the sexes are separate, the male colonies apparently being much more numerous than the female. Of eighty-three colonies observed at different times, sixty were male and but twenty-three female.

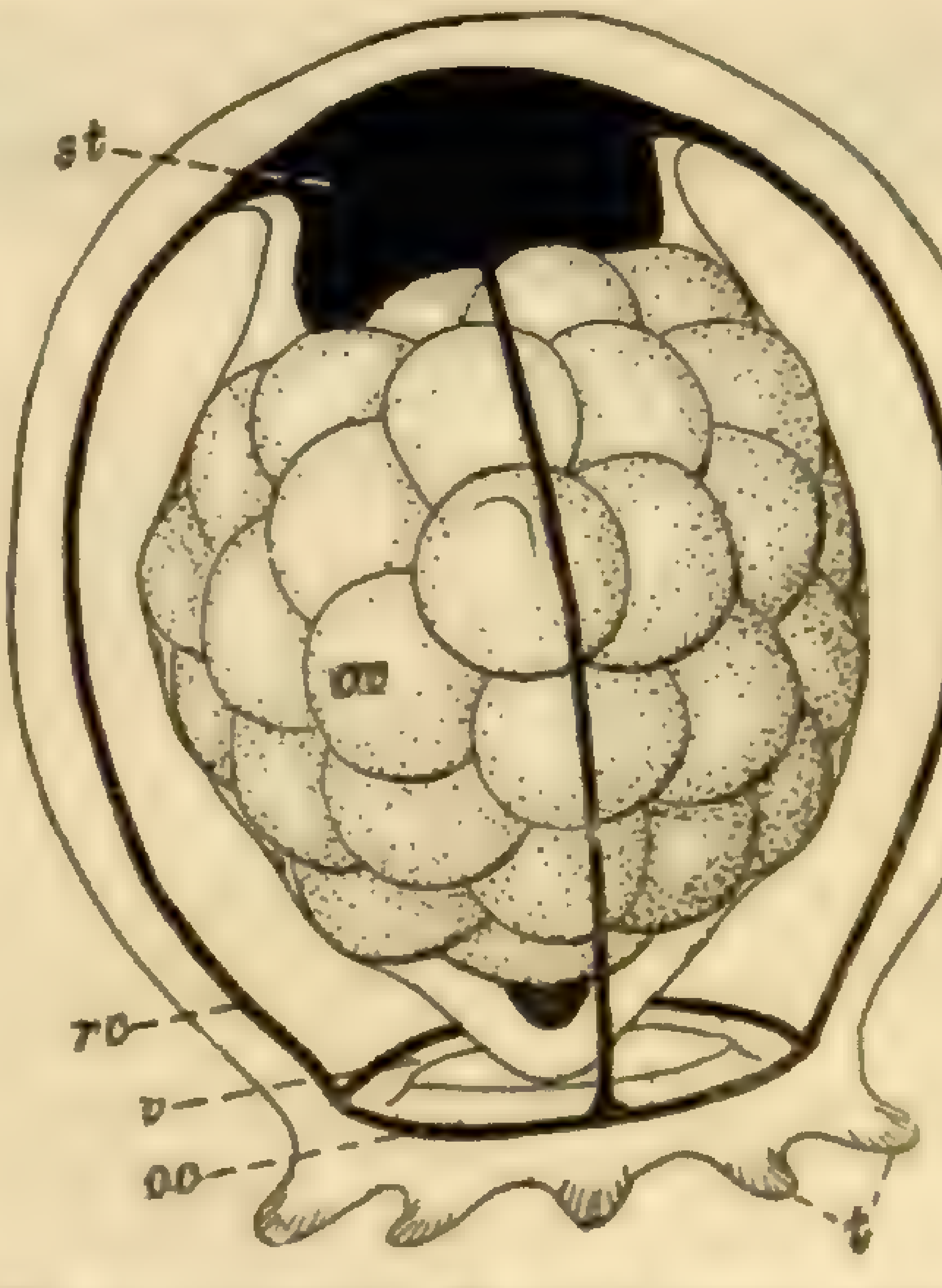


FIG. 4.— Recently liberated female medusa, before extrusion of the eggs. *C.c.*, circular canal; *r.c.*, radial canal; *st.*, stomach; *t.*, tentacles; *v.*, velum; *ov.*, ova. × 50.

The nutritive hydranths (Fig. 2, (1)–(3)), when fully extended, are perhaps more elongate than those of any other marine hydroid heretofore observed. Each arises directly from the tubes of the hydrorhiza, and at the base is covered for a very

short distance only by a continuation of the chitinous perisarc. Each hydranth is essentially a very long tube, consisting of two layers, the ectoderm and entoderm. It is of uniform diameter below, but somewhat swollen at the distal end below the circlet of tentacles. The latter are arranged in a single verticel and number from fifteen to thirty, or even thirty-five. There are usually between eighteen and twenty-five. The tentacles are solid, the entodermal core consisting of a single row of cells. Throughout the length there are stinging cells, but they are more abundant near the tips. The same applies to the hydranth body, in which the stinging cells are much more abundant around the hypostome. The tentacles are frequently bifid.

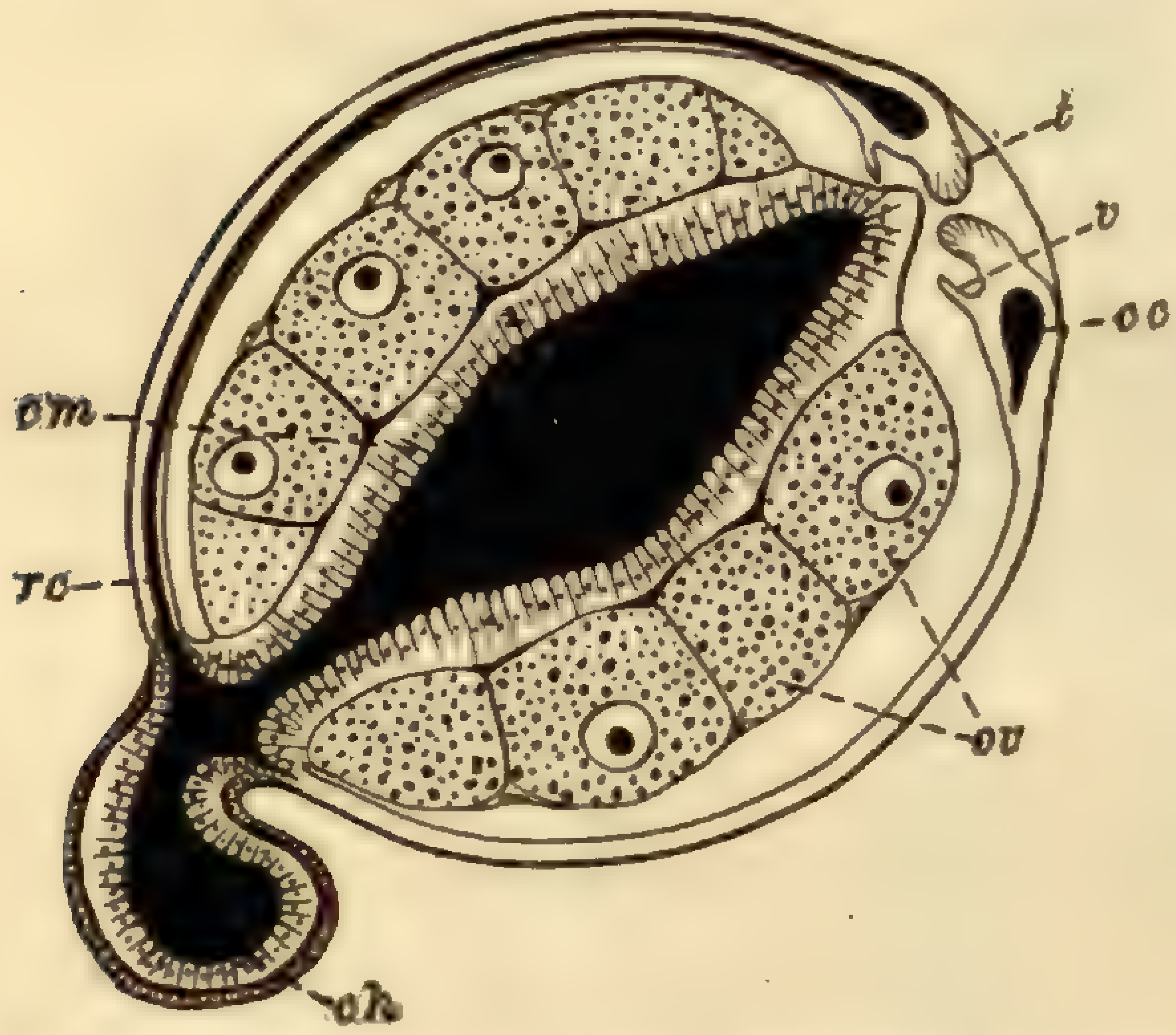


FIG. 5. — Longitudinal section of nearly mature female gonophore. *C.c.*, circular canal; *r.c.*, radial canal; *t.*, tentacle; *v.*, velum; *c.m.*, digestive cavity of gonophore, and *c.h.*, of the hydranth; *ov.*, ova. × 50.

In their general features the reproductive hydranths (Fig. 2, (4) and (5)) are quite similar to the nutritive, the differences in the former being the somewhat smaller size, the smaller numbers of tentacles, and the presence of a variable number of buds which develop into medusæ. In fully developed individuals the number of tentacles varies from six to fifteen, the usual number being eight to twelve. Like those of the nutritive hydranths, they are filiform, of uniform diameter, and arranged in a single circle. The reproductive buds vary in number from one to seven, the usual number being four or five. The presence of buds in various degrees of development in all colonies collected from July 8 to August 16, indicates that the breeding season extends at least through July and August. It may be that it begins earlier and ends later. When mature, the buds are set free from time to time as free-swimming medusæ. Though chiefly concerned with reproduction, these hydranths are also capable of taking food, at least sometimes.

The medusa (Fig. 4) represents a stage in organization that occurs but seldom among the Hydromedusæ. When it is liberated the sexual products, borne on the very large manubrium, are fully matured, so that the medusa after its liberation does not nourish and develop the former, but only distributes them. This done, the medusa dies, after its free-swimming life of a few hours. Its organization is quite simple, a condition to be expected both in connection with the recent liberation and its transitory existence. So far as could be determined, from the very rudimentary condition or absence of the characters usually employed in classification, it belongs most nearly to Haeckel's Dysmorphosa type, in which the mouth parts and tentacles are simple, the latter eight in number.

Though the medusa has most of its structures degenerate, it is still distinctly a medusa. As seen in side view (Fig. 4), it is somewhat higher than wide, its vertical diameter being about 1 mm. Into the cavity of the bell hangs the very large manubrium, which is gorged with sexual cells. There is no mouth opening and no lips nor tentacles around the mouth region. From the upper part of the stomach pass the four radial canals which connect with the circular canal at the edge of the bell. From the outer edge of the umbrella project eight equal rudimentary tentacles, four paradial and four interradial. They bear numerous stinging cells, but eye-spots seem to be absent. From the inner edge of the bell projects the narrow velum. Lining the subumbrella there is a well-developed layer of muscle fibres, and though degenerate in most ways, the medusa swims actively during the few hours of its free life.

In my specimens the medusæ were liberated in the evening, soon after dark, and though it would not be safe to conclude that this always takes place, I am inclined to think that it does. In a species of another hydroid (Pennaria) which the writer observed in Jamaica, and in which the medusæ likewise lead a free life of but a few hours, the latter are liberated within an hour after dark, at almost exactly the same time from day to day. I think the same may be found to hold for the form here described.

The condition of the medusa in this species, when liberated, is of further interest from a systematic standpoint. Allman, in his monograph on the *Tubularian Hydroids*, made the organization of the medusa a diagnostic character for the separation of families within the group. His Hydractinidæ and Podocorynidæ differ only in details from each other, except that in the former the medusoid buds remain in a rudimentary condition in the form of sporosacs, while in the latter the medusæ are liberated and lead a free-swimming life of considerable duration. In the form here described we have an exactly intermediate condition. Should the characters used by Allman stand, a new family would have to be established to include the species here described. But it seems that they are too narrow at this point, and that this species should be included under his family Bimeridæ. If so, it becomes a species of Stylactis. For it I propose the name *S. Hooperii*, after Professor Franklin W. Hooper, the secretary of the Brooklyn Institute, who has contributed so much to the success of the laboratory at Coldspring Harbor.

The hydroid here described is one of the most beautiful and graceful that has been observed. The delicacy of the individuals seems correlated with the protection afforded the colony through association with the Ilyanassa and its habitat in a locality free from high winds. Though the color of most of the colonies is whitish, many are of a pink or olive green or yellowish tint. Its only American ally so far observed is *S. arge*, found in the Chesapeake Bay and described by S. F. Clarke. It differs from the latter, however, which is found attached to the stems of Zostera, in which the eggs develop into planulæ before being liberated; and in which the terminal portion of the hydranths are described as breaking off to establish new colonies.

Diagnosis of the Species S. Hooperii. — Hydrocaulus absent; hydrorhiza a network of tubes lying in one plane, from which arise small, simple spines and the sessile hydranths, which are of two kinds, nutritive and reproductive; they are similar to each other and extremely elongate. The nutritive hydranths may attain a length of two to two and a half centimeters and

bear usually about twenty tentacles, arranged in a single circle. The reproductive hydranths are slightly smaller and bear usually six to ten tentacles and four or five reproductive buds. Medusa becoming free, though degenerate, the sexual products mature when the medusa is liberated. Medusa with four radial canals; eight equal rudimentary tentacles; mouth opening and mouth parts absent; velum developed.

University of Minnesota,
August 21, 1899.

A BALLOON-MAKING FLY.

J. M. ALDRICH AND L. A. TURLEY.

On June 16 of this year, while passing along a country road near Moscow, Idaho, our attention was attracted by some bright white objects moving to and fro in the air at an elevation of eight or ten feet. A second look seemed to indicate that these objects were connected with small insects. On capturing the insects they were found to be males of a species of Empis, each carrying between its hind feet a peculiar structure which is referred to in the title as a balloon. This is of elliptical shape, about 7 mm. long (nearly twice as long as the fly), hollow, and composed entirely of a single layer of minute bubbles, nearly uniform in size, arranged in regular circles concentric with the axis of the structure. The beautiful, glistening whiteness of the object when the sun shines upon it makes it very conspicuous. The bubbles were slightly viscid, and in nearly every case there was a small fly pressed into the front end of the balloon, apparently as food for the Empis, as the attached species were partly Chironomus and partly Oscinids, and other Acalyptrate Muscids. In all cases they were dead.

The balloon appears to be made while the insect is flying in the air. Those flying highest had the smallest balloons. The bubbles are probably produced by some modification of the anal organs, as in Aphrophora and other leaf-hoppers, but no positive observations on this point could be made. It is possible that the captured fly serves as a nucleus to begin the balloon on. One case of a captured fly but no balloon was observed. After commencing, it is probable that the rest of the structure is made by revolving the completed part between the hind legs and adding more bubbles somewhat spirally. The posterior end of the balloon is left more or less open.

The balloons were so light and sticky that they could not be preserved with any success. The first lot obtained were placed

in a corked vial, and had all collapsed by the next day. The second lot were placed in an open vial, which was left on the ground for a little while, and the ants carried off all the specimens. A third lot in open vials retained their shape in some degree, but were all more or less shriveled. One placed in alcohol immediately dissolved.

FIG. 1.

The purpose of this structure is to attract the female. When numerous males were flying up and down the road, it happened several times that a female was seen to approach them from some choke-cherry blossoms near by. The males immediately gathered in her path, and she with little hesitation selected for a mate the one with the largest balloon, taking a position *upon his back*. After copulation had begun, the pair would settle down towards the ground, select a quiet spot, and the female would alight by placing her front legs across a horizontal grass blade, her head resting against the blade so as to brace the body in position. Here she would continue to hold the male beneath her for a little time, until the process was finished. The male, meanwhile, would be rolling the balloon about in a variety of positions, juggling with it, one might almost say. After the male and female parted company, the male immediately dropped the balloon upon the ground, and it was greedily seized by ants.

FIG. 2.

Of the accompanying sketches, Fig. 1 shows the position of

the balloon when the male is flying. It is frequently carried farther back, apparently by the hind legs alone. Fig. 2 shows the position assumed in copulation, the male underneath rolling the balloon.

No illustration could properly show the beauty of the balloon, still less could anything worthy of the subject be made from the shriveled and flattened specimens that now remain in our

Fig 3.

possession. The half-tone (Fig. 3) serves only to show the way it is formed of bubbles.

The only published observations at all comparable with these are on the European species of Hilara, a genus of Empidæ closely related to Empis, and especially on *Hilara sartor* Becker. Several entomologists have published articles on the species, and there has been considerable difference of opinion as to the nature and purpose of the structure carried by the fly, as well as the method of carrying it. Professor Mik, in the

Wiener Entomologische Zeitung, Vol. XIII, pp. 271–284, and Pl. II, Figs. 8–13, gives an exhaustive discussion of the whole subject, with citations of the other authors and extracts from their papers. According to Mik, who had abundant opportunities for observation, the male produces a real web which is borne by the hind feet and serves to assist the fly in the somewhat peculiar gyrations of its flight. The different nature of the structure makes it unnecessary to go into further particulars here.

The species to which our observations pertain was sent to Professor Wheeler, of Chicago, who has been studying the family for several years, and identified by him as *Empis poplitea* Loew, "or a closely related species."

The use of the term "balloon" should not be taken to imply that the structure described is lighter than air.

HAVE WE MORE THAN ONE SPECIES OF BLISSUS IN NORTH AMERICA?

F. M. WEBSTER.

It is a fact, well known among entomologists, that the original description of *Blissus leucopterus* Say was drawn up from a single specimen taken on the eastern shore of Virginia. This was, therefore, probably a macropterous individual belonging to the maritime race that inhabited the Atlantic coast. It was not until long after that the brachypterous form was discovered, and attention was first directed thereto by Dr. Asa Fitch in his second report on the insects of the state of New York, and it was figured by Riley in *The American Entomologist*, Vol. I, p. 174, May, 1869, Dr. Fitch designating it as variety *apterus*. The infrequency with which this brachypterous form has been observed in the past is due to its almost universally secluded habits, as will be explained later.

Say's description, in which he named the insect *Lygæus leucopterus*, appeared in 1831, and in 1850 Dr. William Le Baron, afterwards state entomologist of Illinois, having overlooked Say's description, again described the species as *Rhyparochromus devastator*, the description, this time, having been based on material secured in Illinois, where the species was at that time excessively abundant.

According to Professor Cockerell there appeared in 1893, in *Ann. Soc. Ent. Belg.*, Vol. XXXVIII, two additional descriptions, namely, *B. hirtus*, from North America, and *B. pulchellus*, from Central and South America, both by Montandon. As the specimens recorded from the islands of Granada and St. Vincent by Uhler, and which were collected by Mr. H. H. Smith, are said to be of larger size and more variable than *leucopterus* and with fully developed wings, it would seem that Professor Cockerell may be right in thinking that these were, perhaps, Montandon's *pulchellus*. Just what his *hirtus* may

be I am unable to conjecture. *Leucopterus*, or what has been universally conceded as that species, has been collected in Panama and other localities in Central America; but as the collecting was probably somewhat superficial, we have very likely much to learn regarding the species in that country.

Along the Atlantic coast from central Florida to Nova Scotia and inland to northern Indiana, Ohio, and Ontario, we

Figures illustrating variation in wings of Atlantic maritime race of *Blissus leucopterus*.

have what I have here termed a maritime race, composed of individuals of both sexes whose wings may be nearly or quite aborted, or varying between these and the completely winged, and which freely interbreed, both with each other and the inland race, among whom brachypterous individuals are not usually found.

On the Pacific coast, in the vicinity of San Francisco, a similar race occurs, including also brachypterous individuals.

Whether this is in all respects similar to the Atlantic coast race or not is yet to be determined. This last is as yet known only in California, but it is not unlikely that it will in future be found to extend along the entire coast from California southward to Panama. The similar race that occurs along the Atlantic is at present known, to the southward, only to the Atlantic coast of Florida, not having yet been observed, so far as known, anywhere along the Gulf of Mexico. It must be stated, however, that except in the closest proximity to the sea, where Mr. Schwarz has found that it lives on the upper portion of its food plant, these brachypterous individuals are found only about the roots of their food plants, usually slightly below the surface of the soil, so that their detection is not an easy matter, unless one searches carefully for them. It must, therefore, be said that we really do not know whether this race occurs along the Gulf coast or not.

A somewhat extended study of this maritime race in Ohio has disclosed some interesting differences between the habits of this and the exclusively macropterous race inhabiting the interior of the country. These differences, together with minor anatomical ones, have been thought by some entomologists to be sufficient grounds for separating Say's *leucopterus* from Le Baron's *devastator* and making a separate species of each. I will give these differences between the two, as I have found them in Ohio, taking up first the maritime race.

The Atlantic maritime race is composed of brachypterous and macropterous individuals, the relative number of each being, so far as observed, somewhat variable. As the macropterous individuals may take wing and abandon in spring the fields occupied by the two forms jointly, it is obviously impossible to make any estimates of their relative numbers except during hibernation or immediately after the young have developed to adults. I have not found that the macropterous individuals part company with the brachypterous individuals with anything like the celerity or entirety that has been observed in the case of the European species, *Blissus doræ*, as witnessed by Professor Sajö. In our species both forms may be found together at all times, but where a field of corn or wheat adjoins a meadow, the

macropterous individuals only will be found among the grain, while the brachypterous ones will as uniformly remain in the timothy meadow. Among this race I have never been able to detect the slightest indication of a second brood. It is apparently much less affected by wet weather during the breeding season. This has also been observed by the late Dr. Lintner in New York. In the meadows the attack of Sporotrichium is much less marked, but in the insectary this has not proved true, thus indicating that the difference may be one of environment rather than in the resistant power of the insect itself. In the *Report of the U. S. Commissioner of Agriculture* for 1887, Pl. I, Figs. 1–8, the brachypterous maritime form is shown as quite different both in form and color from those found inland. Mr. Schwarz has since stated in *Insect Life*, Vol. VII, p. 420, that this difference in color was unreal, while Dr. Howard wrote me last summer that figures drawn from the material sent him from Ohio represented the maritime individuals much better than Fig. 8, in the plate, in the Commissioner's Report above referred to; so that it would seem that the striking differences there indicated do not exist in fact. Mr. Van Duzee has called attention to a possible difference between specimens from New York and Kansas, the former seeming to be more hairy and robust than the latter, but he writes me that this may have been due more to the season than to the locality.

The inland race has rarely been observed to depredate on timothy, and never in the manner followed by the Atlantic maritime race. It is two-brooded, and all members of the race macropterous, but in confinement freely interbreeds with brachypterous individuals of the maritime race. In Ohio the latter occupies the north and northeastern portion of the state, while the inland race covers the western and southern portion. The only exception to this that I have observed is the finding of two brachypterous individuals in hibernation in southwestern Ohio, not far from the Ohio River. The maritime race might have been brought into southwestern Ohio, either by being washed into the upper Ohio River in the northeastern part of the state and, as with some other species, carried down stream

and deposited in the fields along the river, or, possibly, by pushing through the Allegheny Mountains of Virginia and West Virginia from the Atlantic coast, by way of the valley of the Big Kenawaha River. Whether or not this was actually the case can only be determined by a study of the insect fauna of the Big Kenawaha valley. Mr. C. L. Marlatt, who has been making a study of the genital organs of both the maritime and inland races, writes me that he has not been able to find any material difference between them.

The Pacific coast race has not been carefully studied, or the area over which brachypterous individuals occur. It would indeed be interesting to know whether two races from the same original stock would develop alike, the one on the Atlantic coast and the other on the Pacific, as it would have a bearing on the oft-repeated question as to whether the same species can be evolved in two widely separated localities.

In summing up the testimony, then, the question put in my title can be answered only by saying that, with our present knowledge, there appear to be no differences between our known forms of Blissus, in North America, that cannot be accounted for by environmental influences. In this paper I have given them, tentatively, the position of separate races, but even that term may in future be found inapplicable. It is very significant that one cannot take up the study of an insect so common and well known as the chinch bug without encountering so many and such wide breaks in our knowledge of the species.

SYNOPSES OF NORTH-AMERICAN INVERTEBRATES.

J. S. KINGSLEY.

IV. Astacoid and Thalassinoid Crustacea.

The following synopsis, together with the one given in this journal for September, includes the whole macrurous fauna of North America north of the southern boundary of the United States and within the hundred-fathom line. Geographical distribution is indicated, as before, by full-faced letters : **N**, **M**, **S**, indicating the northern, middle, and southern Atlantic coast; **A**, **P**, **D**, corresponding divisions of the Pacific coast.

The Astacoid forms include those forms familiarly known as lobsters and crayfishes, as well as some others for which no common name is in general use. The crayfishes (genera Astacus and Cambarus) are inhabitants of fresh water; the others are marine. Most important of these is the lobster, once very abundant from New York northward, but now becoming much more rare, owing to overfishing and to disregard of the law prohibiting the taking of immature and egg-bearing animals.

The crayfish are fresh-water forms, occurring sparingly in New England and the southern British Provinces, and far more abundantly in the rest of our territory, where every stream and pond has its representatives. The discrimination of the species is not easy, and for the present we give no key to the fifty-one species described from our limits. The difficulties which surround the systematic arrangement of these forms can be seen from the fact that the late William Stimpson, our most accurate student of the Crustacea, would not touch the crayfish, remarking that either we had only one species of Cambarus in our country, or each mud puddle had its own species.

In the southern waters and on our Pacific coast the lobster

is replaced by the Palinurids or spring lobsters, and by the flattened Scyllarids. These groups are frequently united by European carcinologists under the name Loricata. They are extremely interesting, on account of the peculiar leaf-like larvæ (Phyllosoma) which hatch from the eggs. In these the body is scarcely thicker than a sheet of this paper, but it may be two or three inches in length and half as broad.

The Thalassinids are marine burrowing forms, living in the sand and mud and frequently showing the effects of this life in the very soft and membranous integument, the pincers alone being hardened in some of these Crustacea.

The most important papers relating to the description of our American species are: —

MILNE-EDWARDS. Histoire Naturelle des Crustacés. Tome ii. 1837.

DANA. Crustacea of the United States Exploring Expedition. 1852.

STIMPSON. Crustacea of Pacific Coast. *Journ. Boston Soc. Nat. Hist.* Vol. vi. 1857.

HAGEN. Monograph of the North American Astacidæ. *Mem. Mus. Comp. Zoöl.* Vol. iii. 1870.

SMITH. Invertebrates of Vineyard Sound. *Rep. U. S. Fish Commission for 1871–72.*

SMITH. Preliminary Notice of Crustacea [etc.]. *Proc. U. S. Nat. Mus.* Vol. iii. 1881.

RANDALL. Catalogue of Crustacea [etc.]. *Journ. Acad. Nat. Sci. Philadelphia.* Vol. viii. 1839.

STIMPSON. Notes on North American Crustacea. *Annals N. Y. Lyc. Nat. Hist.* Vol. x. 1871.

GIBBES. *Proc. Am. Assoc. Adv. Sci.* Vol. iii, pp. 192–195. 1851.

KINGSLEY. *Bull. Essex Inst.* Vol. xxvii, p. 95. 1897. Vol. xiv, p. 131.

FAXON. A Revision of the Astacidæ. *Bull. Mus. Comp. Zoöl.* Vol. x. 1885.

KEY TO ASTACOID AND THALASSINOID CRUSTACEA OF THE UNITED STATES.

1. Macrura (see *Am. Nat.*, vol. xxxiii, p. 708) 2
2. Carapax with two longitudinal sutures; cervical suture frequently present; antennal scale small or wanting . . Thalassinoidea 12
2. Carapax without longitudinal sutures; cervical suture frequently present; antennal scale small or obsolete . . . Astacoidea 3
2. Carapax without sutures; antennal scale large Caridea (see p. 713).
3. Antennal scale usually present; anterior feet chelate; body sub-cylindrical; abdomen large . . . . Astacidæ 4

3. Antennal scale absent, anterior feet monodactyl 8
4. Hand of chelipeds large, broad, margins rounded, surface convex Astacinæ 5
4. Hands of chelipeds prismatic, sides nearly straight (Nephropsinæ) 7
5. Last thoracic segment not mobile; species marine . *Homarus* 17
5. Last thoracic segment free from the rest; fresh water . . 6
6. Branchiæ 17; species from the Atlantic water shed . *Cambarus* 22
6. Branchiæ 18; species from the Pacific slope . . *Astacus* 18
7. Antennal scale absent; chelipeds densely pubescent . *Nephropsis* 23
7. Antennal scale present; chelipeds naked and carinate *Nephrops* 24
8. Body strongly depressed, lateral portions of carapax thin, margins inflexed; antennæ lamellate . . . . . Scyllaridæ 10
8. Body and base of antennæ sub-cylindrical . . . Palinuridæ 9
9. Antennæ nearly touching at base; antennular flagella and rostrum short . . . . *Palinurus* 26
9. Antennæ remote; antennular flagella long; rostrum absent *Panulirus* 25
10. Carapax elongate or sub-quadrate 11
10. Carapax transverse, sides incised.[1]
11. Rostrum well developed; antennæ touching at the base; exopodite of external maxilliped with flagellum . . . . *Scyllarus* 27
11. Rostrum very short; antennæ remote; no flagellum to exopodite of external maxillipeds . . . . *Arctus* 28
12. Branchiæ thoracic; external maxillipeds pediform; caudal fin broad Gebidæ[2] 13
12. Branchiæ thoracic; external maxillipeds expanded operculiform; caudal fin broad . . . . Callianassidæ 16
13. Second pair of feet monodactyle, no antennal scale . . *Gebia* 34
13. Second pair of feet didactyle; a small antennal scale . . 14
14. Eyes normally pigmented 15
14. Eyes destitute of pigment and cornea . . . *Calocaris* 37
15. Hand of chelipeds regularly chelate . . . . . *Axius* 35
15. Hand sub-chelate, the pollex folding on the palm . *Naushonia* 36
16. Eyes sub-lamellate; antennular flagella longer than preceding joints: second pair of feet chelate . . . . . *Callianassa* 29
16. Eyes cylindrical; antennular flagella rather shorter than peduncle; second pair of feet chelate . . . . . *Callichirus* 33

[1] *Ibacus parræ* (West Indies) and *Evibacus princeps* (Lower California) may occur within our limits.

[2] By the characters of the maxillipeds the genus Glypturus would belong in the family Gebidæ, but Stimpson gives no characters of second pair of feet or of presence or absence of an antennal scale. He compares it with *Callianassa grandimana*. *G. acanthochirus* comes from Florida. The writer has seen no specimens.

SYNOPSIS OF SPECIES.

Group ASTACOIDEA.

Family ASTACIDÆ. Sternum narrow; abdomen slightly narrower than cephalothorax.

Genus *Homarus* Milne-Edwards. Lobsters. Rostrum slender, conical, with a few teeth on sides.

17. . . . . . . *H. americanus* Milne-Edwards **N**, **M**

Genus *Astacus* (Fabr.) Milne-Edwards. First segment of abdomen with appendages. Species confined to Eurasia and the Pacific slope of America.

18. Margins of rostrum denticulate 19
18. Margins of rostrum not denticulate 20
19. Rostral acumen long; chela not barbate . *A. nigrescens* Stimpson
19. Rostral acumen short; chela barbate . . *A. gambeli* (Girard)
20. Rostrum short, with short acumen; postorbital ridge without posterior spine . . . . *A. klamathensis* Stimpson
20. Rostrum long, with long acumen; postorbital ridge with posterior spine or tubercle 21
21. Posterior spine of postorbital ridge long; cardiac areola half as broad as long . . . . *A. leniusculus* Dana
21. Posterior spine small or tubercular; areola one-third as broad as long *A. trowbridgii* Stimpson
22. Genus *Cambarus* Erichson. First segment of abdomen with appendages. Species confined to waters draining into the Atlantic. Fifty-one species and several varieties recognized by Faxon within our limits. Reference should be made to his monograph for identification.

Genus *Nephropsis* Wood Mason. Species from deep water.

23. Two pairs of lateral spines on rostrum . *N. aculeatus* Smith **M**

Genus *Nephrops* Leach.

24. . . . . *N. occidentalis* Randall[1]

Family PALINURIDÆ. Antennal base long, stout; sternum trigonal; none of the feet chelate. Tropical and temperate in our waters; animals of large size, familiarly known as spiny lobsters.

Genus *Panulirus* Gray.

25. No spine in median line of gastric region; posterior border of the lateral angles of abdominal segments with a single spine; basal joint of antennulæ very long . . . . . *P. americanus* (Lam.) **S**
25. Gastric region with seven spines, the middle one largest, sulci of abdominal segments interrupted in middle, except on last segment *P. interruptus* (Randall) **P**, **D**

Besides, *P. guttatus* and *P. argus* may occur in Florida. They have not been reported from there.

[1] Described by Randall from "the west coast of North America." Probably was from the Hawaiian Islands. See *Bull. Essex Inst.*, vol. xiv, p. 131.

Genus *Palinurus* (Fabr.) Gray.

26. . . . . *P. longimanus* Milne-Edwards **S** (?)

Family SCYLLARIDÆ.

Genus *Scyllarus* Fabr. Branchiæ 21.

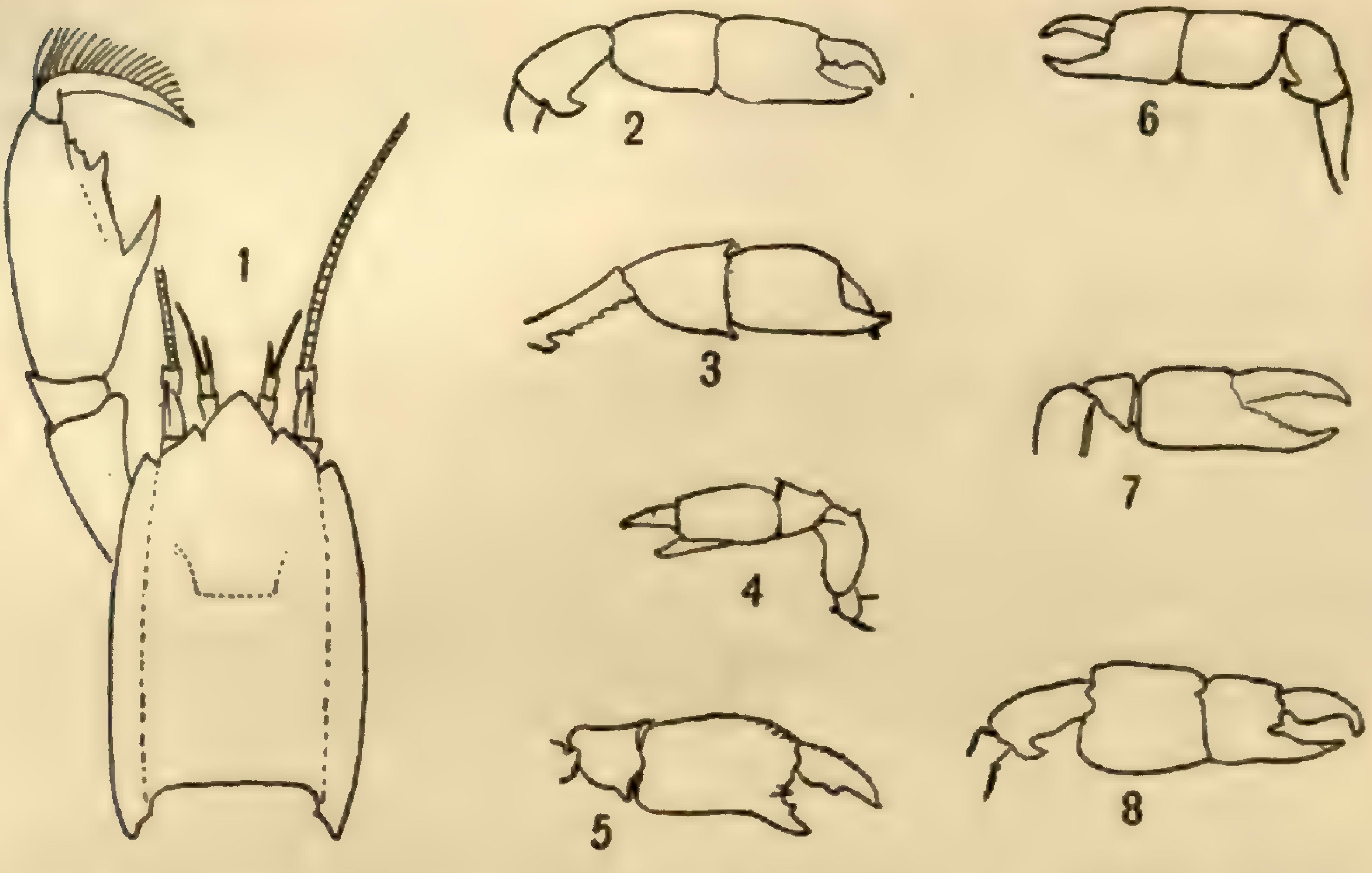
27. Gastric region without spines; posterior border of third abdominal segment regularly arcuate . . . *S. æquinoxialis* Fabr. **S**

27. Gastric region with bidentate projection; third abdominal segment with a strong knob . . . . *S. nodifer* Stimpson **S**

Genus *Arctus* Dana. Branchiæ 19.

28. Antepenult segment of antenna with two teeth on external margin; sternal segments without conspicuous spines *A. americanus* Smith **S**

28. Antepenult segment of antenna with three teeth, sternal segments with conspicuous spines . . . . *A. depressus* Smith **M**



Chelæ of Thalassinoid Crustacea. — (1) Naushonia crangonoides; (2) Callianassa longimana; (3) Callianassa gigas; (4) Gebia affinis; (5) Gebia pugettensis; (6) Callianassa stimpsoni; (7) Axius serratus; (8) Callianassa californiensis.

Group THALASSINOIDEA.

Family CALLIANASSIDÆ.

Genus *Callianassa* Leach. Chelipeds unequal in size, carapace smooth and glossy.

29. Meros of larger cheliped serrate below, palm nearly twice length of carpus . . . . *C. grandimana* Gibbes **S**

29. Meros of larger cheliped with a strong proximal spine below . 30

30. Carpus and palm sub-equal 31

30. Carpus about twice the length of the palm 32

31. Meros short, tapering towards distal extremity; carpus without distal spines . . . . *C. longimana* Stimpson **P**

31. Meros long, broadest at distal end; carpus with distal spines above and below . . . . *C. gigas* Dana **P**

32. Height of carpus and palm sub-equal; no notch in palm below insertion of dactylus . . . . . *C. stimpsoni* Smith **M**

32. Carpus considerably higher than palm; a notch in palm just below articulation of dactylus . . . . *C. californiensis* Dana **P**

Genus *Callichirus* Stimpson.

33. Body membranous; carpus and hand very long . *C. major* Say **M, S**

Family GEBIDÆ.

Genus *Gebia* Leach. Rostrum rough and hairy, chelipeds sub-equal.

34. Pollex with strong tooth on inner margin; carpus smooth above, with a strong distal spine . . . . *G. pugettensis* Dana **P, D**

34. Pollex without tooth; carpus with a spine above, and five or six spines at tip . . . . *G. affinis* Say **M, S**

Genus *Axius* Leach.

35. Abdomen broader than carapax; no teeth on dorsal carina of carapax *A. serratus* Stimpson **N, M**

35. Abdomen narrower than carapax; dorsal carina toothed *A. armatus* Smith **M**

Genus *Naushonia* Kingsley.

36. . . . . *N. crangonoides* Kingsley **M**

Genus *Calocaris* Bell. Hand slender, pollex elongate; rostrum triangular.

37. . . . . *C. macandreæ* Bell **N**

REVIEWS OF RECENT LITERATURE.

GENERAL BIOLOGY.

Action of Salt Solutions upon Eggs. — Few now underrate the value of physiological experimentation as an aid in the advance of pure science as well as a basis for practical arts, even though the results obtained may be but abnormal states of the organisms studied; it is a hopeful sign of the times that these methods are being so actively extended to the study of the lowest organisms and even to the sphinx-like mystery of the egg. An important venture in this direction is that of Professor T. H. Morgan,[1] who now adds a second paper to his first account of notable discoveries published three years ago.

This paper contains the results of arduous labor, and is illustrated by careful drawings. Only a few of the many important facts and inferences can be touched upon here.

The author found that sea-urchin eggs, whether fertilized or not, when placed a short time in sea water to which two per cent or less of sodium or magnesium chloride has been added, and then returned to common sea water, show inside clear spots which change position and number. When these eggs are sectioned and stained, the clear spots are represented by darkly stained regions and radiating lines — in fact "stars" comparable to those seen in karyokinesis. Some stars have central specks comparable to centrosomes.

If the eggs are not fertilized, they may nevertheless, when so treated, undergo a process of cleavage into many cells. The cleavage, however, is not like the normal, nor does it lead to the formation of larvæ, so far as known. Sections of such eggs show that the chromosomes are distributed through the egg, apparently by the action of the stars, and that the cleavage of the egg takes place about these chromosomes as centers.

In some other animals, notably a Nemertean and a Gephyrean, similar star-formations were produced by treating the unfertilized eggs with the same salt solutions.

It is thus possible to bring out stars and centrosomes similar to the normal ones, but in abnormal numbers and positions, by mere

[1] *Archiv f. Entwicklungsmechanik*, 1899, Bd. viii, pp. 448–536, Pls. VI–X.

excess of some of the salts common in sea water. Moreover, eggs that have not been fertilized may cleave in such changed sea water, and in this cleavage there are divisions and distributions of chromosomes with accompanying activities of centrosomes and of asters.

There is, of course, room for doubt and for difference of opinion as to the light shed by these abnormal processes upon the normal ones in the basic phenomena of fertilization and of cleavage. The author cites facts that show the power of the egg to cleave without the centrosome and the aster, and thinks the chromosome part of the nucleus the most influential part of each cell. As cleavage may take place without reference to asters, mechanical hypotheses of contractile bands or pushing rods seem to him unnecessary.

Centrosomes, he thinks, may be formed *de novo* from protoplasm outside the nucleus or within it, and may sometimes persist and in other cases be of short life. His results are to some extent iconoclastic, and he would depose the centrosome from its assumed rôle of hereditary monarch.

The author sees in these results of adding salts no direct mechanical phenomena, but only the reactions of living eggs when stimulated by changed environment. The egg becomes more a living thing than it seemed when we were ignorant of these possibilities.

Holding this standpoint, the author would do well to abandon his term "artificial stars," since it does not appear that these reactions to salts are more *artificial* than those produced by adding sperm, nor, in fact, than the reaction of a frog's leg when salt is placed upon it.

E. A. A.

History of the Natural Sciences. — The first volume of Dannemann's *Grundriss einer Geschichte der Naturwissenschaften*, which contains so admirable a series of selections from the works of the most distinguished natural scientists of the past, has been supplemented by a second volume,[1] in which the historical development of the natural sciences is dealt with. The subject-matter of this volume is largely astronomical, physical, and chemical; and the arrangement essentially chronological. While it is to be admitted that chemistry and physics are in a sense more fundamental than the biological sciences, and, therefore, deserve a certain degree of precedence in an historical account, it is to be regretted that so important

[1] Dannemann, F. *Grundriss einer Geschichte der Naturwissenschaften;* 2. Bd., *Die Entwicklung der Naturwissenschaften*, 435 pp., 76 illustrations. Leipzig, W. Engelmann. 1898.

and interesting a subject as the historical development of the biological sciences should have been passed over so lightly as in the present volume; for of its 425 pages only about 30 are devoted to the growth of biology, whereas in the first volume the biological selections cover some hundred of its 325 pages. Excepting for this disproportionateness, the second volume is fully equal to the first, and will afford profitable reading to those interested in the development of physical and chemical science. The work is well illustrated. G. H. P.

ANTHROPOLOGY.

The Races of Europe.[1] — In the preface to this important work Professor Ripley states that "it represents merely an honest effort to coördinate, illustrate, and interpret the vast mass of original material — product of years of patient investigation by observers in all parts of Europe — concerning a primary phase of human association: that of race or physical relationship." The book itself is the product of a vast amount of patient research, nor is the modest disclaimer of its author, that it contains nothing that is, strictly speaking, original, to be taken too literally. In some respects this volume justifies the statement that the Caucasic division of the human family "is in point of fact the most debatable in the whole range of anthropological studies"; on the other hand, it contributes more than any other single publication to refute the charge by bringing "this abundant store of raw material into some sort of orderly arrangement," and in its lucid exposition of the facts relating to the more difficult problems.

The work is based upon a course of lectures upon "physical geography and anthropology," subsequently published in *Appletons' Popular Science Monthly*; the notices thus called forth have sufficiently commended the plan and purpose of the work. The introductory chapter emphasizes the significance of geography from the standpoint of human interests; in fact, the interrelation of race and environment is the keynote of the whole volume. In his chapter upon language, nationality, and race the author maintains that the fundamental importance of ethnic conquests has not been commonly recognized by historians, and that it is not the direct relation of his-

[1] Ripley, W. Z. *The Races of Europe.* New York, D. Appleton & Co. 1899. 8vo, 624 pp.

torical movements to topographical features that furnishes the most fruitful field for research. Head-form, pigmentation, and stature are the three physical characters selected as sufficient criteria for the determination of the distribution of the races of Europe. But the greatest of these is head-form, or cephalic index; it is beyond the reach of artificial selection, wonderfully persistent within the group, and is a character observable with ease and accuracy. The color of hair and eyes is a much more complex factor, more subject to individual variation, also to variation with age; hair and eyes may be of the same color, or may vary independently of each other, and, finally, it is difficult to correct for the personal equation of different observers, so that "the precision of measurements upon the head is nowise attainable." Professor Ripley considers the evidence as yet insufficient to determine the cause of pigmentation. "It is not certain that the true cause lies in the modifying influences of climate alone." With some reserve, he accepts Livi's conclusion that blondness is due to unfavorable environment, yet inconsistently ascribes the blondness of the Teutonic peoples to that environment which has produced the most admirable physical type of all Europe; to be sure he regards artificial selection as a factor in the development of both the blondness and the tall stature of the Teutons, but Westermark's refutation of this hypothesis should be considered final. By the combination of these three traits, three races are formed — the Teutonic, Alpine, and Mediterranean. In an appendix an instructive comparison is drawn between this simple classification and that by Dr. Deniker, who distinguishes six main and four secondary "varieties." The Teutonic is regarded as the most characteristic and thus justifies the name — *Homo europæus* — bestowed upon it by Lapouge. The broad-headed type is termed "Alpine" rather than "Celtic," as "geographical names are least equivocal" and the "Celtic question" involves the discussion of philological and archæological data as well as somatological. The third "race" is long-headed, dark, and short in stature.

The succeeding seven chapters deal with these races as they exist within the various national and linguistic divisions of Europe. While the Jews do not belong to any of these European races, their numbers — six or seven millions — and peculiar racial solidarity render them of surpassing interest and importance to the anthropologist. Incidentally, Professor Ripley sounds a word of warning here: "This great Polish swamp of miserable human beings, terrific in its proportions, threatens to drain itself off into our country as well,

unless we restrict its ingress." The remarks upon the habits of life among the Jews that conduce toward longevity are suggestive. The Jews of New York, engaged in one of the most deadly occupations known, live nearly twice as long as their American neighbors, even those engaged in out-door labor. Our author's final conclusion is rather startling: "It is paradoxical, yet true, we affirm. The Jews are not a race, but only a people, after all." "No purity of descent is to be supposed for an instant." However, the table of observations on the cephalic index would seem to establish clearly the purity of the race and disprove his conclusion.

The political and anthropological problems centering in the Orient are set forth in two chapters dealing with the several racial groups found there, most of whom are not, strictly speaking, members of the three European races. Regarding the physical origin of the European races Professor Ripley concludes that as a whole they are intermediate between the Asiatics and Negroes; that the earliest population of Europe was dark and dolichocephalic, probably represented by the Mediterranean race of to-day; that the Teutonic race is a variety of the aboriginal, long-headed people which has acquired its distinctive tall stature and blondness from the effects of environment and artificial selection; that the Alpine type having Asiatic affinities overran Europe because of its superior culture, but that in time the Teutonic race reasserted itself and the constant tendency in recent times has been to push back the Alpine type into the "areas of isolation." From the data furnished by prehistoric archæology Professor Ripley summarizes as follows: During the later Stone Age an entirely indigenous culture was evolved in western and southern Europe; it was characterized by great technical advance in ornamentation, by construction of dolmens, by pottery-making, "and possibly even by a primitive system of writing." Throughout the Alpine highlands the higher Hallstatt culture, exhibiting Oriental affinities, appeared a thousand years or more before the Christian era. "This prehistoric civilization represents a transitional stage between bronze and iron." This culture roughly overlies the area occupied by the Alpine type. Progress is discernible, so that much of this culture was developed on the spot, that is, it was of European origin. The prehistoric Italian culture was due to the union of two cultures, the Hallstatt and one coming from the southeast, by sea, being distinctly Mediterranean. Throughout the prehistoric period the northwestern corner of Europe was characterized by backwardness in culture.

In the discussion of the subject of environment versus race, Professor Ripley asks if the student of social phenomena should acquaint himself with "the nature of the human stuff of which populations are compounded," or if these investigations are of merely academic interest. He points out some of the errors and even absurdities that result from the attempts of the "anthropo-sociologists" to classify social phenomena on an ethnic basis. "Contact of mind with mind is the real cause," and the appeal to the social geography of different countries at once discloses the contradictions that exist in the distribution of social phenomena amongst the different races. In the section upon social problems it is shown that the segregation of people into localized communities and of others into castes is a thing of the past. "Under the pressure of modern industrialism and democracy" both these forms are breaking down, and the geographical cleavage of locality and nationality as well are threatened. Economic and social attractions draw the country populations to the city. European cities are growing more rapidly in population as a result of this migration than are the urban centers of America. This is accompanied by a corresponding decrease in the population of the country districts. "The fact is that western Europe is being gradually transformed into a huge factory town." The inert sedentary character of the Alpine peoples prevents them from migrating in any great degree to the cities, so that the pressure of social forces tends to accentuate the mental differences now existing between Teutonic and Alpine types. But urban selection is more complex than the mere migration of a racial element toward the cities, and physiological and social rather than ethnic selection seems to be at work.

The closing chapter deals with the problems of acclimatization, and is of especial interest to every American citizen at this time. The questions that present themselves are, first, "can a single generation of European emigrants live? and, secondly, living, can they perpetuate their kind in the equatorial regions of the earth? Finally, if able permanently so to sustain themselves, will they still be able to preserve their peculiar European civilization in these lands?" After a brief consideration of the physiological peculiarities of race, Professor Ripley concludes that "the almost universal opinion seems to be that true colonization in the tropics by the white race is impossible." And again, "Authorities in favour of the view that complete acclimatization of Europeans in the tropics is impossible might be multiplied indefinitely."

This volume of over 600 pages is illustrated by a large number of portrait types and original maps that set a new standard for anthropological publications. It is accompanied by *A Selected Bibliography of the Anthropology and Ethnology of Europe*, published by the Trustees of the Boston Public Library. Nearly two thousand titles are included in the list.

FRANK RUSSELL.

Anthropological Notes. — In the July *Anthropologist* O. T. Mason presents a report of the discussion, or rather a summary of it by Professor McGee, by the Anthropological Society of Washington on the adoption of the term "Amerind" to designate the aboriginal tribes of the American hemisphere. The word is an arbitrary compound of the leading syllables of the phrase "American Indian." It is brief, euphonious, and lends itself readily to adjectival and adverbial terminations. The adoption of the term is to be heartily commended. In the same number of the *Anthropologist* Dr. Ales Hrdlicka describes and figures "a new joint formation," apparently a unique case of the humerus sending out a new process to form a joint with the dislocated head of the radius. The bones are from an Amerindian burial place in Kentucky.

An anomalous skeleton is described by Hrdlicka in Vol. XII, pp. 81–107, of the *Bulletin of the American Museum of Natural History*. The skeleton was found in the vicinity of the city of Mexico. It has 13 pairs of ribs, and also presents the anomaly known as a "bicipital rib." The sternum is completely ossified — an exceptional condition among Amerindian skeletons, the author states — and its body is perforated by two large foramina. The long bones of the arm exhibit in an accentuated degree the proportions seen in the negro. The femora are platymeric, said to be a frequent type among Amerindians. The tibiæ are proportionally long and their heads are inclined backward. A list of titles of works relating to bicipital, supernumerary, and cervical ribs is given.

In a privately printed booklet of 30 pages W. H. Furness contributes a sketch of the "Folk-lore of Borneo." A charming account is given of the Kayan and Dayak origin myths ; the native conception of the after-life ; the magic power of names ; the custom of head-hunting, etc. Five excellent illustrations of the natives and their surroundings are furnished.

PSYCHOLOGY.

Psychology of Paramecium. — The analysis of the reactions of Paramecium from a psychological standpoint has been undertaken by H. S. Jennings.[1] It is well known that Paramecia will swarm in great numbers around masses of food. It is also well known that they form large shoals after having been dispersed in a fluid, and that they avoid centers of alkaline reaction and frequent regions showing acid qualities. Such reactions as these have led many investigators to conclude that Paramecium has sensations, exerts choice, possesses social instincts, and, in fact, exhibits in an elementary way all the essential characteristics of an intelligent animal. Dr. Jennings's work has shown that Paramecia take up any foreign particles irrespective of their appropriateness as food, and, further, that these organisms will collect around a piece of inert filter paper with as much avidity as around a mass of real food. This is due to the fact that the normal forward motion of the infusorian is suspended the moment the animal comes in contact with a solid body, and the animal lies slowly rotating next the body with which it is in contact. Most solid bodies then become centers around which Paramecia accumulate. The social instinct of forming shoals is shown to be due to the influence of carbon dioxide. When for any reason two or three Paramecia stop together, the amount of carbon dioxide produced seems to be sufficient to ensnare and hold others, and thus the nucleus of a shoal is formed. The large assemblies of Paramecia are held together, not by social instinct, but by their own carbon dioxide. The so-called attraction for carbon dioxide and other acids is shown not to be an attraction. The organisms running at random pass eventually into an acid region, at the edges of which they always react in such a way as to remain within the acid area. In a similar way there is no repulsion from alkalis, but when met the animal reacts by turning aside. In this way the reactions of Paramecium are reduced to simple machine-like responses, which no more require the assumption of intelligence for their performance than does the contraction of an isolated muscle.

G. H. P.

[1] Jennings, H. S. The Psychology of a Protozoan, *American Journal of Psychology*, vol. x, no. 4.

PHYSIOLOGY.

Ocular Changes Induced by Low Temperature. — Du Bois-Reymond long ago pointed out that when a frog is subjected for a considerable period to a freezing temperature the animal responds by contracting the pupils and closing the eyes. Dr. G. Abelsdorff (*Centralblatt für Physiologie*, Bd. XIII, p. 81) has observed a third ocular symptom, namely, a change in the color of the pupil from black to a gray or milk-white. This is due to the formation of a temporary cataract in the cortical part of the lens. On allowing a frog to recover from a semi-frozen condition, the animal regains its activity before the lens is clear and is for the time being blind; eventually the cataract disappears, and the frog is in all respects normal. The author suggests that cataracts of this kind may occur naturally in hibernating animals.

G. H. P.

Birch's Physiology. — A new class book of elementary practical physiology has been prepared by Professor De Burgh Birch.[1] The first hundred pages are devoted to an account of the construction and use of the microscope, ordinary histological methods, and mammalian histology. The account is necessarily meager and decidedly less satisfactory than that given in the ordinary histologies of the day. Thus in the matter of microtomes for paraffin work, a small hand microtome and the old-fashioned Cambridge rocking microtome are the only ones mentioned. The second part of the book, some sixty pages, deals with the chemistry of the body, including food, blood, bile, and urine. The third and concluding part, of about ninety pages, is devoted to experimental work on nerve and muscle, with a few directions for work on the circulation and some of the senses. The illustrations are sufficiently numerous, but poorly described, so that one is left to guess at what much of the lettering means. It is a question whether such books should not be called rudimentary rather than elementary.

G. H. P.

Formation of Fibrinogen. — The formation of fibrinogen in the blood of mammals has been investigated by Albert Mathews.[2] The fibrinogen in the blood of a cat may be removed by repeated bleed-

[1] Birch, De Burgh. *A Class Book of Elementary Practical Physiology.* Philadelphia, P. Blakiston's Son & Co. 1899. 273 pp.

[2] Mathews, A. The Origin of Fibrinogen, *The American Journal of Physiology*, vol. iii, pp. 53–85. September, 1899.

ings, defibrinations, and reinjections. The reformation of fibrinogen takes place normally in the absence of the spleen, the pancreas, the kidneys, the reproductive organs, and the brain; but only in very small amounts if the intestines be removed. Fibrinogen is not formed directly from the proteid constituents of the food, for it readily reforms after protracted fasting. If leucocytosis be prolonged for several days by suppurations, the fibrinogen of the blood increases. Fibrinogen is, therefore, probably produced by the decomposition of leucocytes, especially those of the intestinal area. As the fibrinogen of the blood brings about a contractile fibrillar structure in forming a clot, so possibly the fibrinogen of a cell such as a leucocyte may be connected with the formation of the contractile fibrils of the asters in cell division.

G. H. P.

ZOÖLOGY.

The Rotifera.[1] — In this, the first part of a proposed monographic treatment of the Rotifera, Lund gives the more general results of a study which has been conducted on a broad basis. The author has undertaken to examine the group from a purely objective standpoint, without regard to theories of the primitive nature of the organs of the animals, nor of the relationship of the Rotifera to other groups. The result is the most valuable contribution to the biology, morphology, and classification of the Rotifera that has appeared for many years.

Lund examines successively the principal structures that may be used in classification — the nature of the cuticula, the ciliary organ, the mouth parts, the foot, and the sense organs. A strictly objective comparative anatomical standpoint, unbiased by previous theories, is maintained in this study. The structures in question are traced in all their modifications and transitions throughout the group, and an attempt is made to discover the primitive condition of each, together with the path of evolution in the development of the more striking modifications. The œcological value of the organs is brought throughout into the closest relation with their structure. The result is a classification of the Rotifera differing widely from those based on preconceived ideas as to the relationship of this group to the Trochophora, or to other groups; a classification which

[1] *Denmarks Rotifera. I. Grundtraekkene i Rotiferernes Okologi, Morfologi og Systematik*, af C. Wesenberg Lund. Kjøbenhavn, 1899. 145 pp., 2 plates.

may, whatever its imperfections in detail, be truly called a natural one. In the successive examination of the structures above named, the fact is clearly brought out — a fact more or less patent to all who have worked extensively on the Rotifera — that all the widely separated members of the group are connected by transitional forms with the worm-like Notommatidæ. The latter form thus a central group, from which the others have diverged along different lines. Certain of the Notommatidæ present what must be looked upon as the primitive form of the structures in question — a soft cuticula; ciliary organ, consisting of a flat disk on the ventral side, covered with undifferentiated cilia; forcipate mouth parts, and two pairs of lateral sense organs. From this central group some six or seven lines of evolution in different directions are traced, each marked by successive changes from the primitive form of the organs above mentioned, in correspondence with the life habits of the animals.

These studies form the basis of the classification which follows. In this classification one or two points are worthy of especial mention. The division of the larger part of the Rotifera on the basis of the stiffness or softness of the cuticula into the two general groups, Loricata and Il-loricata, which has proved such a stumbling-block to a natural classification, is done away with. To the presence or absence of the foot little importance is attached. Whether one can or cannot agree in detail with the exact arrangement of the genera within the system as given, I believe it must be admitted that this is the nearest to a natural system of the group that has ever been given, and that it will be upon some such lines as these that the final classification of the Rotifera will be made.

The paper is one deserving of study by all students of the Rotifera. It is, moreover, a model for the way in which the general life relations of animals may be brought into correlation with their morphology and classification; as such it has claims on the interest of others beside the specialist in Rotifera. Unfortunately, the work is rendered somewhat less easily accessible in that it is written in the Danish language instead of in one of the four languages that form the recognized necessary linguistic equipment of the man of science.

H. S. Jennings.

Segmentation of Insect Head. — The segmentation of the insect head, as seen in the Collembola, has been studied by J. W. Folsom.[1]

[1] Folsom, J. W. The Segmentation of the Insect Head, *Psyche*, vol. viii, pp. 391–394. August, 1899.

In addition to the somites represented by the compound eyes and the antennæ, many Collembola possess rudimentary intercalary appendages, indicating a third premandibular somite. The remaining somites are represented by the mandibles, the superlinguæ, the first maxillæ, and the labium. At an early stage these seven somites have each a pair of ganglia; the three pairs of premandibular ganglia unite to form the supraœsophageal ganglion, and the remaining four pairs fuse to form the subœsophageal ganglion. A comparison of the hexapod and crustacean head is shown as follows: —

SOMITE.	HEXAPODA.	CRUSTACEA.
1	Compound Eyes	Compound Eyes
2	Antennæ	Antennules
3	Intercalary Appendages	Antennæ
4	Mandibles	Mandibles
5	Superlinguæ	First Maxillæ
6	First Maxillæ	Second Maxillæ
7	Labium	First Maxillipedes

G. H. P.

The optic nerves of amphibians, according to the researches of Fritz,[1] undergo a total crossing in the chiasma, so that all the fibres from one eye pass to the other side of the brain. The chiasma has the form of interwoven bundles, which in the Urodela are larger in the middle of the nerves and smaller dorsally and ventrally, and in the Anura are larger ventrally and smaller dorsally. The chiasma has relatively few glia cells compared with the optic nerve. The courses of the nerve fibres in the chiasma were demonstrated by ordinary histological methods and degeneration experiments. Four weeks after the extirpation of an eye the optic nerve fibres began to show the first evidences of degeneration, a condition obtained in warm-blooded animals in two days. In seven months after the removal of the eye the severed nerve had entirely disappeared. The process of absorption which accompanies the degeneration of the nerves in Amphibia makes the degeneration method much less satisfactory for these animals than for other vertebrates. G. H. P.

Notes. — The few Ophidian tapeworms heretofore known have been supplemented by the discovery of a new species, *Ichthyotænia*

[1] Fritz, F. Ueber die Struktur des Chiasma nervorum opticorum bei Amphibien, *Jena. Zeitschr. für Naturwissenschaften*, Bd. xxxiii, pp. 191–262, Taf. VI–XI. 1899.

Calmettei Barrois, in *Bothrops lanceolatus* from Martinique. G. Marotel gives (*Arch. Parasitol.*, Vol. II, Part I, pp. 34–42, 4 text-figs.) a full account of its structure and demonstrates its affinity to the fish cestodes of the genus Ichthyotænia.

An interesting case of nursing habits among frogs is reported by Brauer (*Zool. Jahrb.*, *Abt. Syst.*, Bd. XII, 1898, pp. 89–94) for *Arthroleptis seychellensis.* The eggs are deposited on the ground and brooded by the adult, probably the male; when the larvæ desert the shell, they possess posterior extremities, already indicated, and a long tail. They creep onto the back of the adult, fasten themselves, not by the mouth, but by the ventral surface, and undergo the remainder of their development there.

The little-known nematode genera Hystrichis and Tropidocerca, which occur in the crop of shore birds, have been restudied by von Linston (*Arch. f. Naturges.*, 1899, pp. 155–164, Pls. XIII, XIV). Many doubtful points in their structure are cleared up.

"Fresh-water Biological Stations: America's Example," by D. J. Scourfield (*Nat. Sci.*, June, 1899, pp. 450–454), reviews the progress in this line of work here and the apparent lack of interest in England. It is certainly true that in this matter at least "England has not done her duty."

The biological investigation of Lake Erie, under the auspices of the U. S. Fish Commission, has made good progress this year. The party, under the direction of Professor Reighard, was located at Put-in-Bay, O., during July. Among other things may be noted that Trochosphæra appeared again, and *Palæmonetes exilipes* was found in large numbers. During August one party made a reconnoissance along the lake shore, while another worked in the deeper water of the open lake.

The first part of the third volume of Kölliker's *Handbuch der Gewebelehre des Menschen* has just appeared under the editorship of Professor Victor von Ebner, and contains an account of the digestive, respiratory, and excretory organs, together with descriptions of such nearly related structures as the organs of taste, the thymus and thyroid glands, the suprarenal bodies, etc.

No. 5 of the second volume of the *Zoölogical Bulletin* contains the following contributions: "A Male Erpetocypris Barbatus Forbes," by C. H. Turner; "The Reduction Divisions in the Spermatogenesis of Desmognathus Fusca," by B. F. Kingsbury; "Ovarian Structure

in an Abnormal Pigeon," by M. F. Guyer; "Some Interesting Egg Monstrosities," by C. W. Hargitt; "A Redescription of Pariotichus Incisivus Cope," by E. C. Case; and "On the Pithecoid Type of Ear in Man," by H. Ayers.

Beginning with the third volume, the *American Journal of Physiology* will be issued in monthly instead of quarterly parts. In this change, however, an increase in the total annual output is not contemplated. The first number under the new arrangement contains the following articles: "The Relaxation of the Bladder Muscles of the Cat," by C. C. Stewart; "The Reaction of Amœba to Lights of Different Colors," by N. R. Harrington and E. Leaming; "Metabolism in the Submaxillary Gland during Rest and Activity," by Y. Henderson; "Studies in the Contraction of Smooth Muscle," by R. S. Woodworth; and "A Comparative Study of Reflex Action after Complete Section of the Spinal Cord in the Cervical or Upper Dorsal Region," by B. Moore and H. Oertel. The second number is made up as follows: "The Origin of Fibrinogen," by Albert Mathews; "A Contribution to the Comparative Physiology of Compensatory Motions," by E. P. Lyon; "The Functional Adaptability of Afferent Nerve Fibres," by S. P. Budgett and J. Green, Jr.; and "Comparison of the Effects of Certain Inorganic Solutions and Solutions Containing Serum Albumin on the Rhythmic Contractility of the Frog's Heart," by E. C. Walden.

The second part of Vol. XV of the *Journal of Morphology* contains the following articles: "The Ovarian Egg of Limulus, a Contribution to the Problem of the Centrosome and Yolk Nucleus," by J. P. Munson; "The Lateral Line System of Batrachus Tau," by C. M. Clapp; and "Comparative Cytological Studies, with Especial Regard to the Morphology of the Nucleolus," by T. H. Montgomery, Jr. It is to be regretted that while this number is dated November, 1898, it should not have been issued till August, 1899.

NEWS.

By the death of Sir William Henry Flower, which occurred July 2, England loses one of her best vertebrate zoölogists. He was born in 1831, was educated as a surgeon, but since the early sixties his work was largely in zoölogical lines. In 1884 he was placed in charge of the Natural History division of the British Museum, a post which he held until last year. He was best known to students from his text-book on the osteology of the Mammalia and the work on the Mammalia produced in collaboration with Dr. Lyddeker.

Mr. Emerson McMillin, of New York, has given $1000 to the research fund of the American Association for the Advancement of Science.

The collection of birds, chiefly European, made by Henry E. Dresser, and which served as the basis of his "Birds of Europe," has been acquired by the Manchester Museum. It contains about 10,000 specimens.

Drs. Dohrn of Naples, Fischer of Berlin, and Treub of Buitenzorg were recently elected foreign members of the Royal Society.

Professor Henry G. Jesup, who has held the chair of botany in Dartmouth College for twenty-two years, has resigned.

Professor V. M. Spaulding will resume his work in botany in the University of Michigan this fall.

Science has a correspondent of sensitive temperament, whose ear is offended by the term "pot hole"; he would suggest the term "remolino" in its place.

An Entomological Society has been founded in Albany, N. Y. Dr. E. P. Felt, the state entomologist, has been elected president.

The sons of the late Professor Jules Marcou have presented his geological library, consisting of 3,000 volumes, 10,000 pamphlets, and 1,200 maps, to the American Museum of Natural History in New York.

Dr. Adolf Fick, professor of physiology in the University of Würzburg, has resigned at the age of 70.

The next lectures on the George William Huntington foundation at the Johns Hopkins University will be given by Professor W. C. Brögger, of the University of Christiania, in April, 1900. He will take for his subject modern deductions regarding the origin of igneous rocks.

Over fifty students attended the Coldspring Harbor Biological Laboratory during the summer just past.

An egg of the great auk, slightly cracked, was recently sold in London for 300 guineas.

Recent appointments: M. Ardaillon, professor of geography at Lille. — Carlton R. Ball, assistant in the division of agrostology of the United States Department of Agriculture. — Elmer D. Ball, assistant entomologist in the Colorado Experiment Station at Denver. — Dr. Dante Bertelli, of Pisa, associate professor of anatomy in the University of Padua. — Ernst A. Bessey, assistant in the division of vegetable physiology and pathology of the Department of Agriculture. — H. Blodgett, assistant botanist and entomologist at the Experiment Station at Jamaica, N. Y. — Dr. J. Warwick Brown, examiner in zoölogy in the University of Aberdeen. — Dr. O. W. Caldwell, professor of botany in the State Normal School at Charleston, Ill. — Dr. E. Wace Carlier, professor of physiology in Mason College, Birmingham, England. — M. Chatin, professor of anatomy at Bordeaux. — Judson F. Clark, assistant in botany in Cornell University. — J. F. Collins, instructor in botany in Brown University. — Dr. G. Davis, assistant professor of applied anatomy in the University of Pennsylvania. — Dr. M. von Frey, professor of physiology in the University of Würzburg. — M. Guitel, adjunct professor of zoölogy at Rennes. — Heinrich Hasselbring, assistant in botany in Cornell University. — George J. Hastings, assistant in botany in Cornell University. — Dr. P. C. Bruno Henneberg, docent for anatomy in the University of Giessen. — Dr. A. J. Herbertson, lecturer on physical geography in the University of Oxford. — Dr. W. H. Hobbs, professor of mineralogy and petrology in the University of Wisconsin. — Dr. A. C. Houston, lecturer in bacteriology in Bedford College, London. — Dr. Ida Hyde, assistant professor of zoölogy in the University of Kansas. — Dr. A. Jakowatz, demonstrator in the botanical museum of the University of Vienna. — Dr. Hermann E. Johanssen, assistant in the zoölogical museum of the University at Tomsk, Siberia. — Dr. K. Keissler, assistant in the botanical museum of the University of Vienna. — P. Beveridge Kennedy, assistant in

the division of agrostology, United States Department of Agriculture. — Dr. Benjamin F. Kingsbury, assistant professor of microscopy and embryology in Cornell University. — Dr. Alfred Kohn, docent in histology in the German University of Prague. — Dr. Henry B. Kümmel, of Chicago, assistant state geologist of New Jersey. — M. Künstler, professor of comparative anatomy and embryology at Bordeaux. — Miss A. Lambert, assistant lecturer in biology in the University of Melbourne. — Professor Malcolm Laurie, examiner in zoölogy in the University at Glasgow. — Dr. R. S. Macdougall, lecturer on botany in the Heriot-Watt College, Edinburgh. — Curtis F. Marbut, professor of geology in the University of Missouri. — Dr. Rudolf Martin, professor extraordinarius of anthropology in the University of Zürich. — Elmer D. Merrell, assistant in the division of agrostology, United States Department of Agriculture. — Dr. W. D. Merrell, instructor in botany in the University of Rochester. — Mr. E. A. Minchin, of Oxford, Jodrell professor of zoölogy in University College, London. — Mr. Geo. T. Moore, instructor in botany in Dartmouth College. — W. A. Orton, assistant in the division of vegetable physiology and pathology, United States Department of Agriculture, to study diseases of cotton. — C. S. Prosser, associate professor of historical geology at the University of Ohio. — Dr. August L. Rimbach, instructor in vegetable physiology and pathology in the University of Nebraska. — Herbert F. Roberts, assistant in the Shaw School of Botany, St. Louis. — P. H. Rolfs, professor of botany in Clemson College, S. C. — Dr. E. A. Schaefer, of London, professor of physiology in the University of Edinburgh. — Dr. Friedrich Schenck, professor extraordinarius of physiology in the University of Würzburg. — Hermann von Schrenk, special agent in the division of vegetable pathology of the United States Department of Agriculture, to study the diseases of forest trees. — M. V. Slingerland, assistant professor of entomology in Cornell University. — Dr. Wilson R. Smith, instructor in botany in McMaster University, Toronto. — Dr. Sommer, docent for physiology in the University of Würzburg. — Dr. E. H. Starling, Jodrell professor of physiology in the University of London. — G. A. Stonier, specialist in mining on the Geological Survey of India. — Dr. Strickelson, privat docent for geography in the University of Basel. — Professor Ph. van Tieghem, professor of the biology of cultivated plants in the National Agrionomic Institute at Paris. — H. G. Timberlake, instructor in botany in the University of Wisconsin. — Dr. M. Treub, director of the botanical gardens at Buitenzorg, Java. — Miss H. V. Whitten, tutor in geology in the

University of Texas. — Dr. K. M. Wiegand, instructor in botany in Cornell University. — D. L. Wilder, of Des Moines, Iowa, assistant on the Iowa Geological Survey. — Dr. Gregg Wilson, lecturer on biology in the Royal Veterinary College at Edinburgh, and lecturer on zoölogy at the Heriot-Watt College.

Deaths: Professor Balbiani, the well-known embryologist of the Collége de France, aged 75. — Dr. Ernst Beinling, assistant in the Botanical Experiment Station in Karlsruhe, in May. — Professor H. R. Geiger, sometime assistant on the United States Geological Survey, at Springfield, Ohio, July 18. — Mr. N. R. Harrington, instructor in zoölogy in Western Reserve University, in Atabara, Egypt, of typhoid fever, July 27. — Stefan Ph. Jakshich, professor of botany in the University of Belgrade, May 15. — The French geologist, Adolphe Legeal, has been murdered in the Sudan. — Christian Lippert, cryptogamic botanist, in Vienna, May 21. — Alphonse de Marbaix, professor of zoölogy in the Agricultural Institute at Louvain. — Dr. Joseph Mies, anatomist and anthropologist, in Cologne, June 9, aged 39. — W. W. Norman, professor of biology in the University of Texas, in Boston, about the first of July. — Dr. Gustaf Pernhoffer, botanist, in Vienna, May 17. — Wilhelm Rudel, student of Coleoptera and Lepidoptera, in Breslau, April 30, aged 81. — Rev. Jonathan Short, of Hoghton, England, a geologist and antiquarian, May 17, aged 73. — Henry Thomas Soppitt, mycologist, in Halifax, April 1, aged 40. — John Whitehead, collector and explorer, in the island of Hainan, aged 43.

CORRESPONDENCE.

To the Editor American Naturalist:

Sir, — In your May issue, p. 437, you publish a note by D. S. J. referring to the recent *Report of the Thetis Trawling Expedition on the Coast of New South Wales.* Your contributor writes: "The nomenclature is very antiquated, the author apparently depending almost entirely on *Günther's Catalogue of the Fishes of the British Museum*, the one published volume of Boulenger's masterly catalogue being ignored."

In common justice the writer might have taken note of the following passage on page 27 of the publication: "The present report is of a popular character, and has been prepared rather for the benefit of the commercial than the scientific community. To this end the technical names employed are not necessarily those of strict science, but are those by which the various fishes are best known to amateurs both in science and fishing." The nomenclature is mainly that of the catalogue of the fishes of New South Wales, by J. Douglas-Ogilby, a work largely used by those for whom the report was written.

That I did not ignore Boulenger's catalogue should be apparent from the occurrence in the report of the names *Cæsioperca lepidoptera*, *Epinephelus septemfasciatus*, and *Acanthistius serratus*.

I am, sir, yours faithfully,

Edgar R. Waite.

Australian Museum, Sydney, June 16, 1899.

PUBLICATIONS RECEIVED.

(The regular Exchanges of the *American Naturalist* are not included.)

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VOL. XXXIII, NO. 395 NOVEMBER, 1899

THE AMERICAN NATURALIST

A MONTHLY JOURNAL
DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE

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THE

ıERICAN NATURALIST

Vol. XXXIII. *November, 1899.* No. 395.

THE WINGS OF INSECTS.

J. H. COMSTOCK AND J. G. NEEDHAM.

Chapter V.

The Development of Wings.

I. First Appearance, Position, and Growth of Wings.

The development of wings is one of the many subjects of biologic study which have been first undertaken in their more difficult phases. The internal processes concerned in the making of an insect wing were first studied by Weismann in the Diptera,[1] and in those Diptera in which conditions are most difficult of interpretation. One by one forms of less complexity have been studied, and a rational account of the process of wing development has at length found its way into several textbooks. The process is still most fully illustrated, however, by studies of representatives of the two groups which are least typical for insects as a whole, the Diptera and the Lepidoptera. Rehberg's inconclusive paper on wing development in *Blatta*

[1] Weismann, A. *Zeit. wiss. Zool.*, vol. xiv (1864), pp. 187–336.

germanica[1] remains the only considerable atte... making of the wing in an insect with incomplete ... In this chapter we give the results of some studie... have endeavored to follow the phylogenetic or... development.

It is not necessary to trace in this place the steps the present state of knowledge of wing development h... reached; for this has... well done by several wri... Among the more comple... of these summaries are those of Gonin[2] and of Pratt.[3]

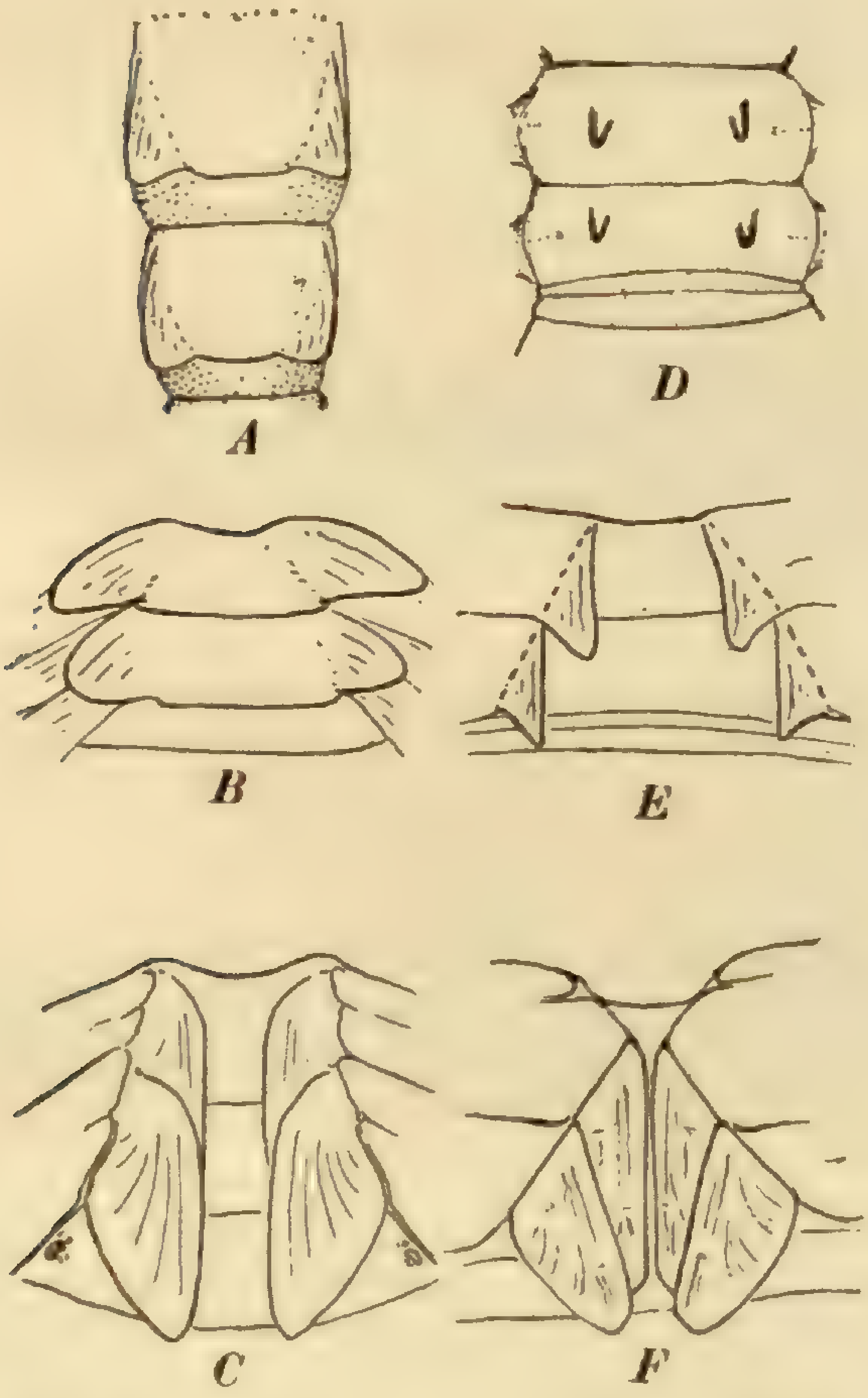

FIG. 82. — Wings of nymphs: *A*, of a stone fly (Capnia); *B* and *C*, of a grasshopper; *D*, *E*, and *F*, of a dragon-fly. In the four lower figures the dorsal half of the body of the nymph is represented as spread out flat. Figures *B* and *E* are from nymphs one third grown; and *C* and *F* from nymphs that were three fifths grown.

Neither does it seem desirable to enter into a detailed discussion of controverted points, our object being merely to state what is definitely known on this subject, and to add the results of some of our own investigations.

It is well known that the wings of insects arise as sac-like folds of the body wall of the second and third thoracic segments. These folds first appear at the point where the suture between the tergum and the pleurum later develops. In most insects with incomplete metamorphosis they are so directly continuous with the tergum and become so solidly chitinized with it that they have generally been interpreted as outgrowths from its caudo-lateral margin (Fig. 82, *A*, *B*).

[1] Rehberg, A. *Jahrb. d. k. Gymn. zu Marienwerder*, 1886.

[2] *Bull. de la Soc. Vaud. des Sci. Nat.*, vol. xxi, pp. 90–98.

[3] *Psyche*, vol. viii (1897), pp. 15–30.

In the Plecoptera, Ephemerida, Hemiptera, Blattidæ, *et al.*, the external changes during growth are comparatively slight — increase in size and internal differentiation, and the development of the veins and of the basal articulations. In the more specialized Orthoptera there occurs the well-known reversal of position of the wings at the last molt. In the Odonata there are the noteworthy differences that the wings arise in an erect position upon the body wall, and at midway the length of their respective segments, and not from the hind margin (Fig. 82, *D*). They appear at a time when the tergum and the pleura are very

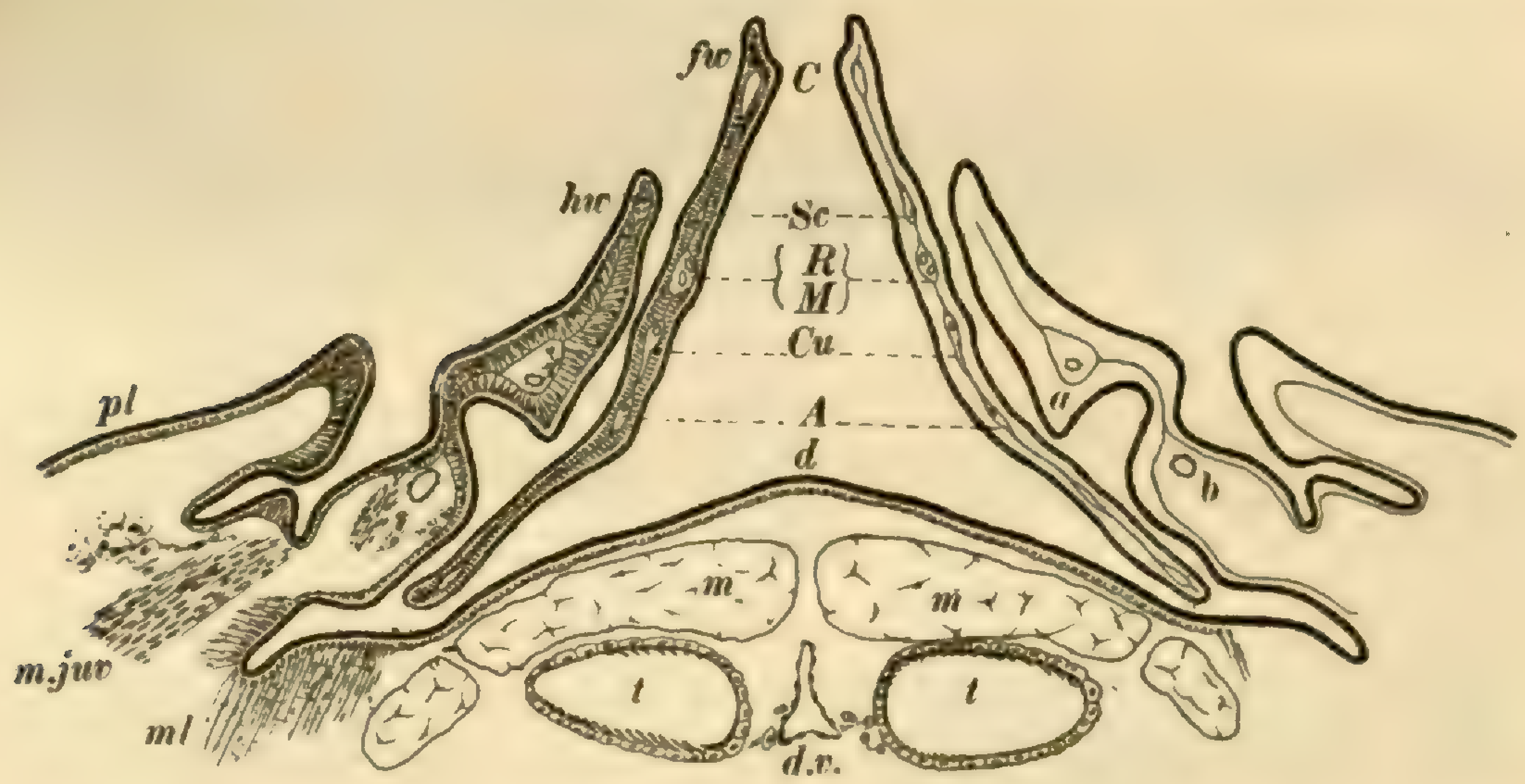

FIG. 83. — Dorsal part of a transverse section of a nymph of *Celithemis elisa*, one third grown: *d*, dorsum; *pl*, pleurum; *d.v.*, dorsal vessel; *t*, *t*, tracheæ; *m*, *m*, muscles in cross-section; *ml*, muscles in longitudinal section; *m.juv*, developing muscle of the wing; *hw*, hind wing; *fw*, fore wing; *a* and *b*, the cut ends of the basal transverse trachea of the hind wing; *C*, costa; *Sc*, subcosta; *RM*, the coalesced radius and media; *Cu*, cubitus; *A*, anal vein.

little chitinized, and are hardly more identified with one than with the other. Later, as in the saltatorial Orthoptera, owing to a rapid growth of the pleura, especially at the wing bases, they are pushed over upon the dorsum and lie in an inverted position (Fig. 82, *E*, *F*), to be righted only at the final transformation.

Fig. 83 shows the relations of parts in a dragon-fly nymph one third grown. It represents a partial cross-section passing through the posterior part of the basal attachments of the hind wings and through the fore wings just before the arculus. In the hind wings are seen (*a*, *b*) the cut ends of the transverse

basal trachea. In the fore wings the tracheæ in the vein cavities are seen in section. The pleura (*pl*) are seen overlying the bases of the wings.

It is interesting to follow the basement membrane of the hypodermis throughout the section, noting how the hypodermal cells are elongated in certain parts, rounding out the sharp

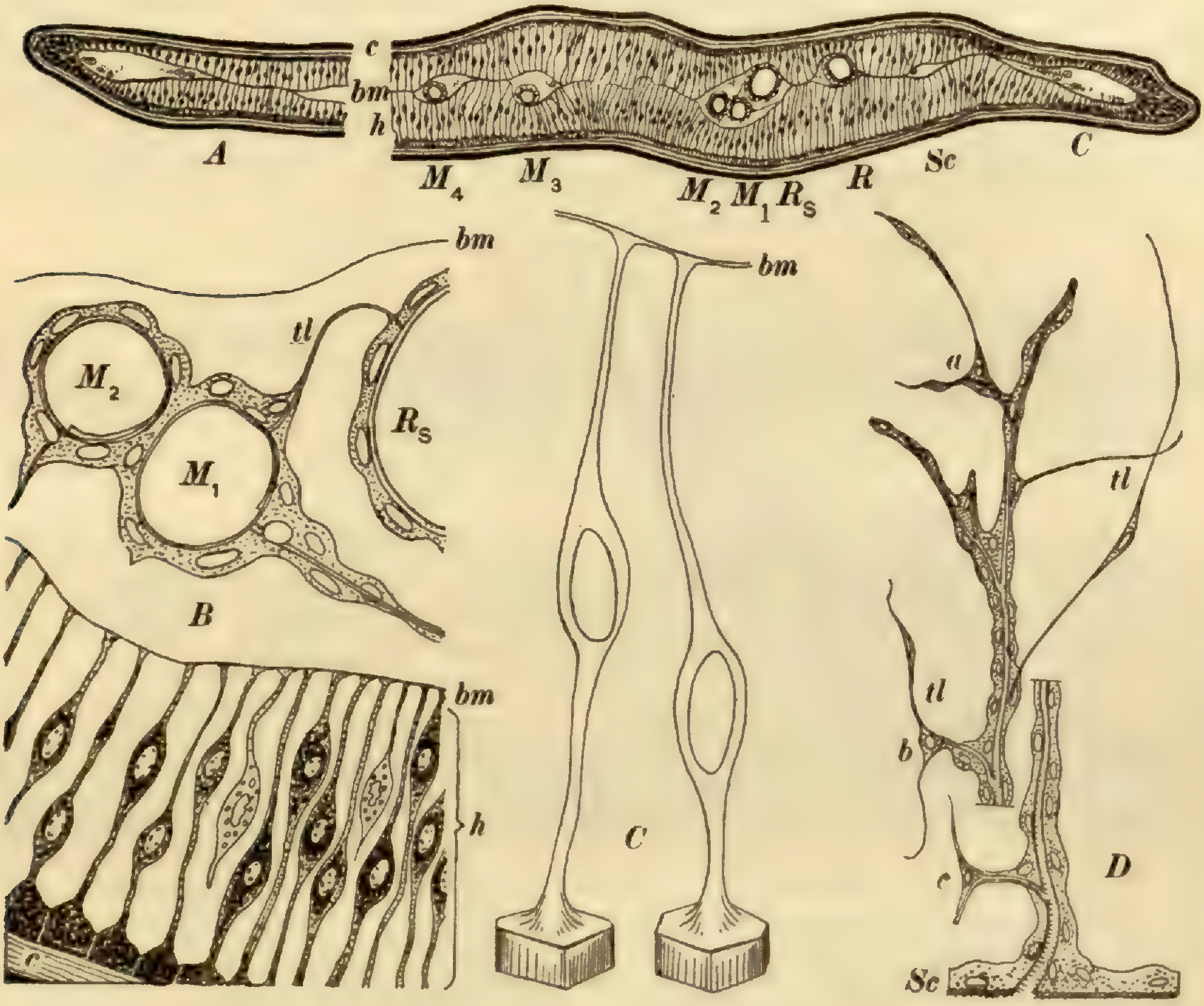

FIG. 84.—*A*, cross-section of a fore wing (in part omitted) of a nymph, two thirds grown, and recently molted, of *Anax junius*; *c*, cuticle; *bm*, basement membrane; *h*, hypodermis; the veins of the wing are designated by the usual lettering. *B*, a small portion of the same, more highly magnified; *tl*, tracheole; *C*, two hypodermal cells from the same; *D*, base and apex of the fifth antecubital trachea, as seen in horizontal section, of another wing of the same specimen; *Sc*, epithelium and intima of one side of subcostal trachea; *a*, *b*, *c*, cells at origin of tracheoles; *tl*, *tl*, tracheoles.

angles of the exterior, and completely occupying the narrower spaces in the wings.

It is also important to note that the basement membrane of the hypodermis of the wing differs in no respect from that of the hypodermis of the body wall, and is continuous with it. In the thinner parts of the wing the two basement membranes meet and fuse, thus forming what has been termed the middle

membrane of the wing. Along certain lines, seen in section in the figure, the two membranes remain separate, and thus are formed the cavities of the wing-veins.

Fig. 84 represents a partial section of a fore wing of a nymph of *Anax junius* two thirds grown; the section was taken at the nodus. The general features here seen are common to the wings of all nymphs—two layers of very elongate, hypodermal cells, which meet in places and form the middle membrane, and remain separate in other places, forming the vein cavities, which usually contain tracheæ. At *B* and *C* in the figure is shown the character of the commoner hypodermal cells.

There is in insects with a complete metamorphosis another type of wing development; this is so different in its external aspects that it may best be described, with respect to these, separately, after which the common fundamental features of wings may be considered.

It has been abundantly shown by others that modification of the type of wing development has kept pace with the increasing complexity of the metamorphosis. The wing-buds are most erratic in the headless, appendageless larvæ of the higher Diptera, Hymenoptera, etc., while they are simplest in larvæ possessing a head, legs, and mouth parts, and especially in those in which the structure is altered least in transforming to imagoes. Among coleopterous larvæ are some in which, save for the appearance of wings, the change is slight; and, indeed, in certain of these (notably the meal worm) specimens are occasionally found with the wings developing externally.

A little coccinellid beetle (*Hippodamia 13-punctata*) has furnished us simpler and more instructive conditions of wing development with complete metamorphosis than have heretofore been fully presented. Fig. 85 shows three early stages in the development of the wings of this insect. Each wing begins as a disk-shaped thickening of the hypodermis (Fig. 85, *A*), which was first observed when the larva was about one fifth grown. A prominent spine, which stands at its dorsal margin, is an excellent landmark to aid in finding it at the first, and when found it is certainly recognized by a slightly concen-

tric arrangement of its cells. It is not at first in connection with nor in approximation to any trachea. The disk elongates and then becomes folded upon itself, thus initiating the wing surfaces. At the time of the folding the wing retreats from the surface, settling down into a pouch-like invagination of the hypodermis (Fig. 85, *C*). Thus it approaches a lateral tracheal trunk, from one of whose smaller branches a few small tracheoles now enter it. As growth continues, the wing extends itself slowly ventrally, as shown in Fig. 86; the mouth of its enveloping pouch becomes somewhat closed by the growth and extension of the pleural hypodermis, but to very various degrees

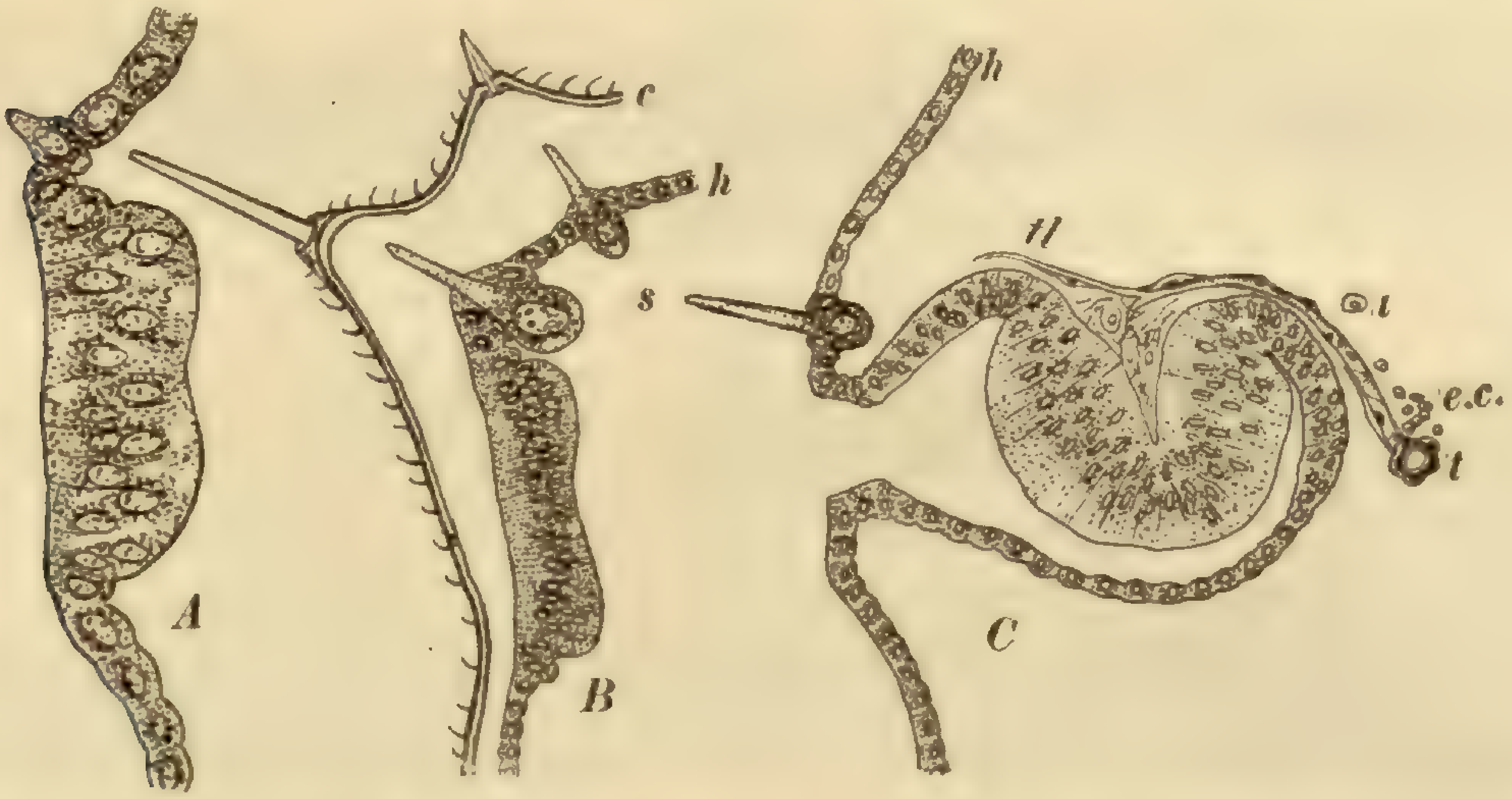

FIG. 85.—Three stages in the early development of wings in *Hippodamia 13-punctata*: *A*, from a larva about one fifth grown; *B* and *C*, from older larvæ, less magnified; *c*, loose cuticle, shown only in *B*; *h*, hypodermis; *s*, spine; *t*, trachea; *tl*, tracheole; *l*, leucocyte; *e.c.*, embryonic cells.

in different specimens, a large part of the larval wing being often found covered exteriorly only by the chitine of the integument.

During the last larval stage the wing is pushed outward and the fold of hypodermis overlying its edges is withdrawn radially, and it emerges from its pouch, becoming greatly extended ventrally under the old larval cuticle, with its walls thrown into numerous folds. When the last larval skin is shed, a still greater expansion transforms it into a wing of the pupa.

Previous to their emergence from the larval wing pockets, there is no appreciable difference between the fore and the hind wings; after this, however, the elytron shows a distinctly

thicker layer of hypodermis on its dorsal side, and the thinness of the hind wings steadily increases with their expansion in area. The hind wings are greatly expanded at the final transformation, while the elytra are almost as large in the pupa as in the imago.

Comparing now the two types of wing development (external and internal), we see that, despite great superficial differences, there are important common features. In both cases the wings arise in early life and form a double plate-like fold of hypodermis, between whose layers tracheæ shortly penetrate. In the former the extension of the wings is gradual and moderate, excepting at the time of transformation; in the latter they early settle down into deep hypodermal pockets, in which their extension is of necessity retarded, although cell multiplication seems not to be.

The principal structural elements which enter into the making of the insect wing are hypodermis, tracheæ, nerves (which, though always mentioned and once or twice figured by other students, we have rarely seen in wings), leucocytes, embryonic cells, and, possibly, sometimes fat cells. Of these, the first two only are essential structures; and these are so important as to merit special treatment.

II. The Origin of the Tracheation of the Wing.

In wings developing externally like those of a dragon-fly one sees the principal tracheæ passing very early out into the wing-bud, branching freely and forming by multitudinous terminal anastomoses a network of capillary tracheoles. In a horizontal section of a nymphal wing one may see how the branches of the tracheæ are formed. Fig. 84, *D*, is from such a section. It will be observed that the terminal tracheoles are intracellular, the tracheæ intercellular; but that there is easy transition from one condition to the other.[1]

In a wing so mounted that the tracheal system is filled with

[1] There are no such distinct transition cells between tracheæ and tracheoles as Holmgren found (*Anat. Anz.*, vol. xi, pp. 340–346) in the spinning glands of caterpillars, although the cells at *a*, *b*, *c* might seem to stand in the same relation.

air it is easy to see everywhere anastomoses between the distal ends of the tracheoles. This is not shown in our figure; indeed, it is difficult to see it in sections anywhere. The walls of the tracheoles are of extreme tenuity; the best of chitine stains leave them untouched; they are probably protoplasmic tubes at their extremities, such as would best subserve the respiratory process. Tracheoles of this type are everywhere relatively short.

In the much discussed tracheation of the lepidopterous larval wing there are the two well-known systems: the temporary

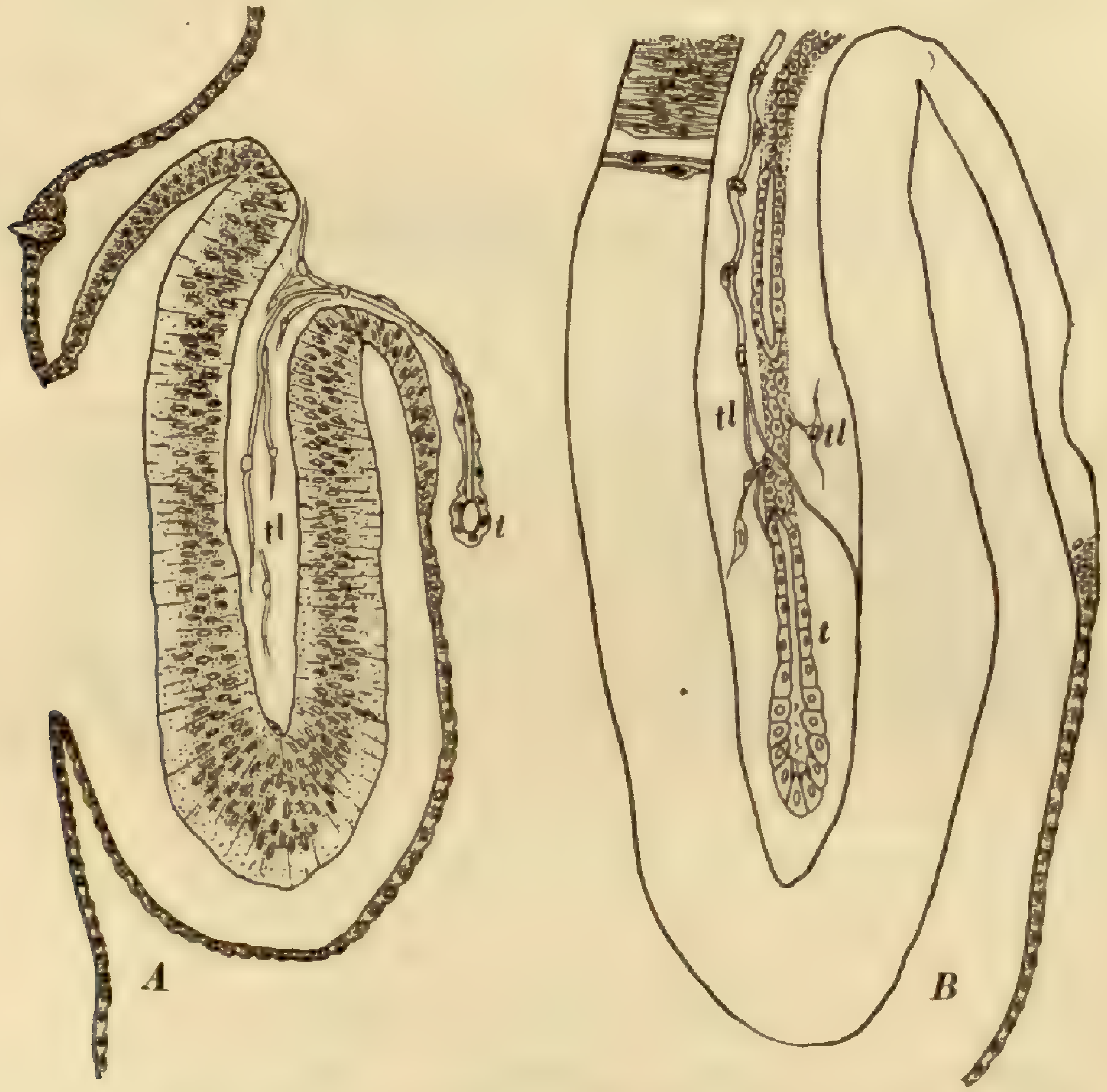

FIG. 86. — Wings of *Hippodamia 13-punctata*, two stages later than those shown in Fig. 85: *t*, *t*, tracheæ; *tl*, *tl*, tracheoles.

system of tracheoles, which enter the wing in the penultimate larval stage and which are functional in the last larval stage; and the permanent wing tracheæ, which grow out into the wings in the last larval stage, but do not become functional until pupation, when they have acquired terminal and lateral tracheoles of their own. In each case the developing air-vessels arise from the epithelium of the lateral tracheal trunk; but they do not communicate with the lumen of this trachea

till after a molt, their mouths being closed at first by the preexisting intima of this trachea. Fig. 86, *B*, will show clearly that in beetles we have the same conditions, though here the temporary system is much less highly developed. This is from a well-grown larva; *tl* is a tracheole; only such are present in the younger wing shown at *A* in this figure; *t* is a developing trachea; and *tl*, *tl* are developing tracheoles attached to single cells of the wall of the trachea.

We believe that this peculiar temporary system of tracheoles is due to and dependent upon the retention of the wing within the narrow limits of its hypodermal pouch; for its small size alone renders its aëration by simple tracheoles possible. We believe that this also explains the retarded development of the tracheæ. In an externally developing wing it is necessary that the tracheæ should grow with the wing, in order to carry the tracheoles out within reach of the tissues; but when a wing develops internally its length for a long time does not exceed the length of normal tracheoles. In such a wing the tracheæ develop only when needed — at the approach of the time when rapid extension is to take place.

III. The Behavior of the Hypodermis.

The cells of the hypodermis are remarkable, not only for their secretory and excretory activity, but also for their capacity for rapid shifting and readjustment. Their life history is one of alternating conditions: first, growth beneath a limiting layer of chitine; then, sudden lateral extension when the chitine is thrown off at molting.

The typical hypodermis of prismatic hexagonal cells is found only where the body wall is smooth; in short curves and angles, and in folds of the integument, and in the wings where close crowding is followed by enormous expansion their change of form is very great. At their ends, however, these cells maintain fairly constant relations. Externally they must needs cover the surface to provide its integument, internally they join the basement membrane; between these two planes, however, they may assume almost any shape, according to the conditions of

their growth. Their commoner forms are shown in the figures presented herewith.

The basement membrane consists, we believe, of the fused inner ends of the hypodermal cells or of processes from them. It is often incomplete or fenestrated, and it is of extreme tenuity. Semper thought it (in the Lepidoptera) composed of leucocytes applied to the free inner ends of the hypodermal

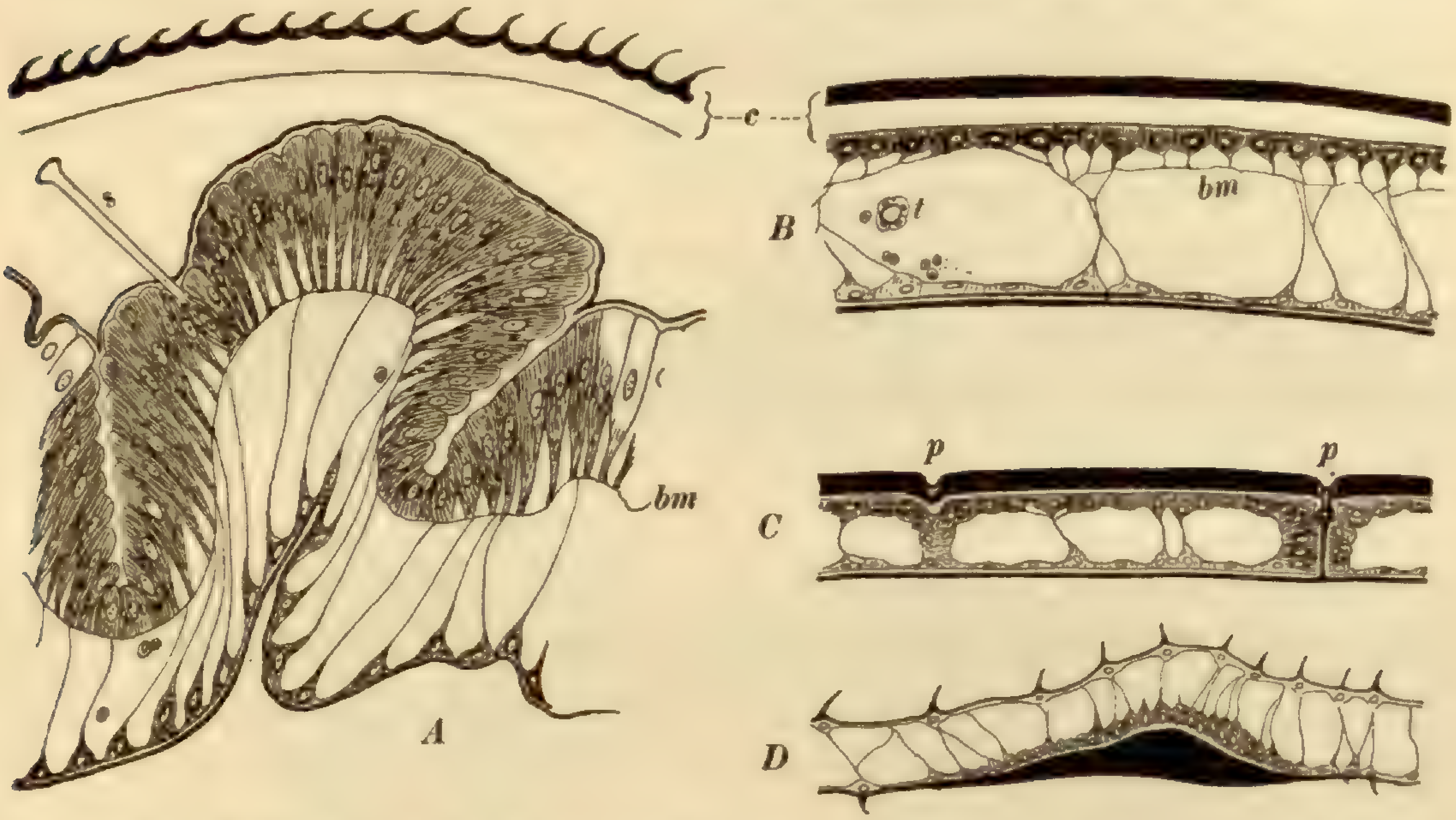

FIG. 87.—Sections of wings of *Hippodamia 13-punctata*, all drawn to the same scale: *A*, from full-grown quiescent larva, a bit of the wing crumpled under the loose larval cuticle; *s*, a deciduous spinule; *bm*, basement membrane; *B*, fore wing (elytron) of an old pupa; *C*, fore wing of a newly transformed imago; *p*, pits above the chitinous pillars; *D*, hind wing of a newly transformed imago, showing especially the manner of formation of a special chitinous brace.

cells, and his opinion has been concurred in by several subsequent investigators; but we are inclined to believe that in the forms we have studied, the formation of it from leucocytes is at least exceptional, for the following considerations:—

1. While leucocytes are not infrequently seen lying against it, we have seen no direct evidence of their participation in its development.

2. During early stages it is well formed and *destitute of nuclei.*

3. In later stages, when, after the expansion of the wing, it contains distinct nuclei, there is evidence that some of these at least are derived from the hypoderm cells whose nuclei, once crowded up to this level, have remained stranded there after the expansion of the wing.

In past accounts of hypodermal development in wings too little attention has been paid to the mechanics of the developmental process—to the varied conditions under which the cells labor in successive stages. To these conditions are mainly due the different cell forms seen; and, except where like conditions are compared, different series will be contradictory. A study of hypodermal ontogeny in the wings of representatives of half a dozen orders of insects convinces us that it is impossible to summarize the process except in the most general terms.

In very early stages in externally developing wings there is found a condition of the hypodermis not far removed from the normal. The cells are only a little less prismatic, a little more columnar or rhomboidal, and the two layers meet internally in very limited tracts. Fig. 89, *A*, is from the wing of a young acridid nymph. It would answer almost equally well for a

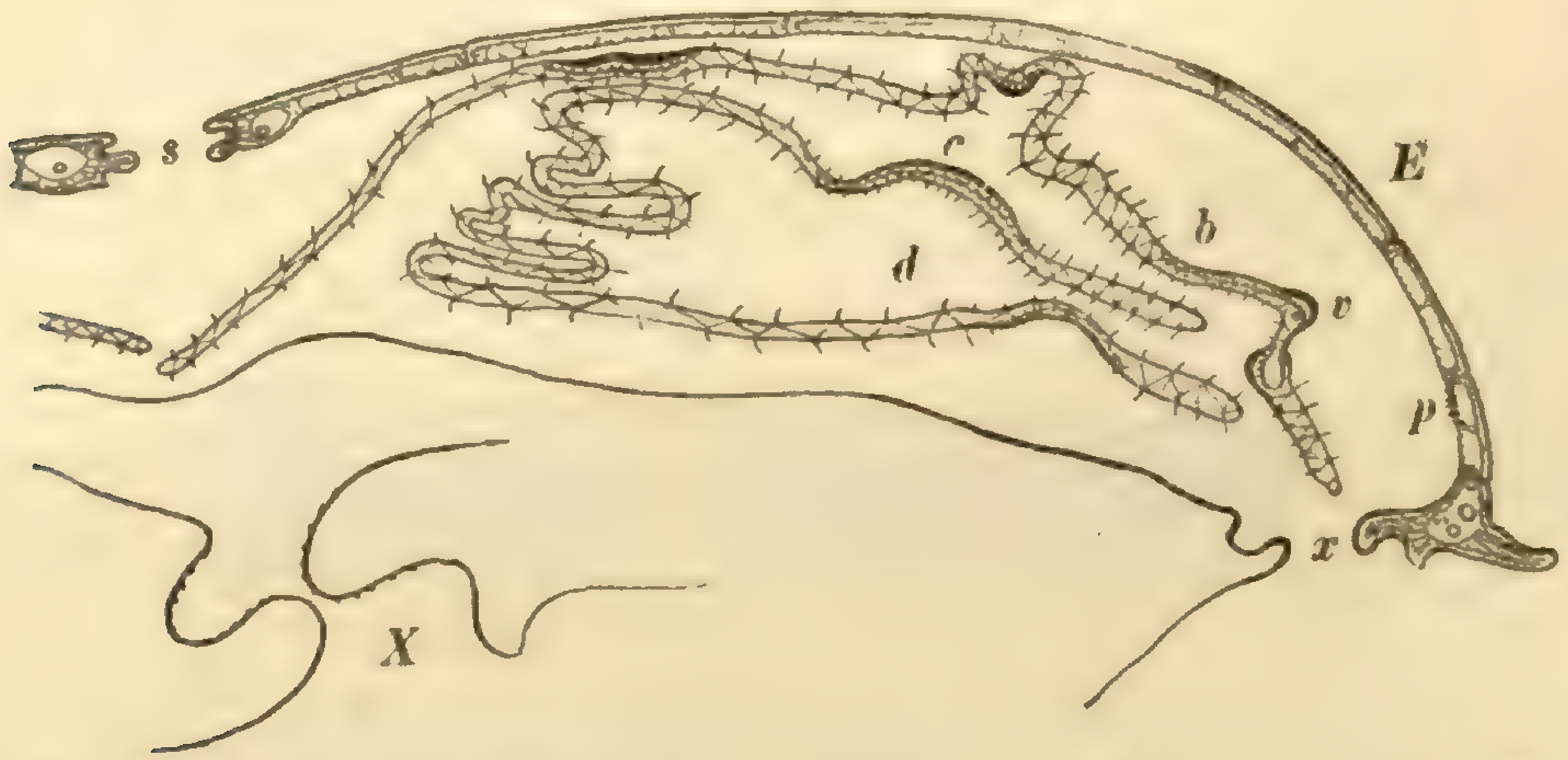

FIG. 88.—Cross-section of wings of a newly transformed imago of *Hippodamia 13-punctata*, *in situ*: *E*, fore wing; *b*, basal portion of hind wing; *d*, distal, reflexed portion of hind wing; *s*, elytral suture; *v*, a vein; *c*, a cuticular thickening; *p*, stridulating (?) processes; *x*, the interlocking ridges, seen more magnified at *X*.

young nymph of the dragon-fly, Gomphus, or for several ephemerids we have studied; or, for that matter, for parts of the ephemerid tracheal gill or for its operculum; or, save for the lack of tracheæ, for the overlapping edge of the prothorax or for a section of the labium.

This early condition is followed by a long period of growth, during which the hypodermal cells become crowded and much more elongated, their nuclei, which were originally nearer their inner ends, coming to occupy a spindle-shaped middle portion in the cells (Fig. 84). The crowding is excessive, and the effect

of it in massing the cells much more marked, of course, when wings are developed internally. But even here the spindle-form cell is recognizable (Fig. 86, *B*), and all the cells appear still to extend from surface to surface of the hypodermis.

The first great expansion of the wing occurs just before pupation, with insects having complete metamorphosis, but not until the final transformation, with those in which the metamorphosis is incomplete. This expansion results in the broadening of the bases of the hypodermal cells, in the settling down of their nuclei close upon the chitine layer, and in the drawing out of their inner ends into a long, slender prolongation, which

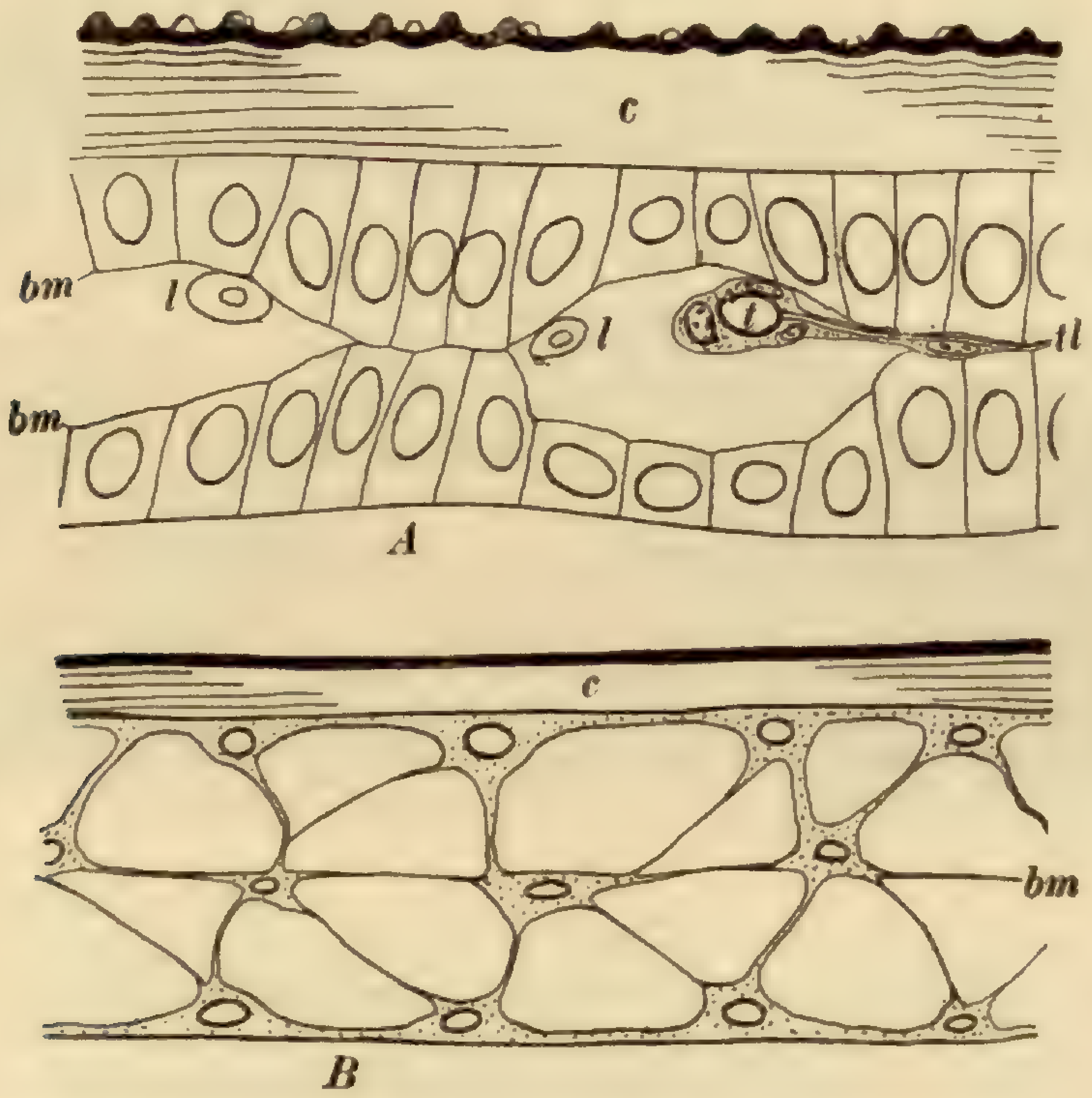

FIG. 89. — *A*, cross-section of the wing of a young acridid nymph: *c*, cuticle; *bm*, *bm*, basement membrane; *t*, trachea; *tl*, tracheole; *l*, leucocyte; *B*, stellate cells in hypodermis, from the anal angle of a wing shown in Fig. 83.

generally retains its attachment to the basement membrane, and thus to its neighbors opposite, in those portions of the wings where the membranes are united. The cells thus become peaked in appearance. Their breadth and height will depend, however, on (1) the extent of the previous crowding; (2) the extent of the surface they are now called upon to cover; and (3) the width of the space they are now called upon to bridge. When, through excessive crowding, some of the innermost

nuclei have come into contact with the basement membrane at the subsequent expansion of the wing, these, instead of retreating with their fellows to the chitine layer, seem instead to remain where they are, and to attract to themselves the slender prolongations of the neighboring cells. They thus acquire a stellate appearance, as shown in Figs. 89, *B*, and 90, *D*. These seem to occur only in narrow spaces, in which great expansion has followed close crowding.[1] We have found them in Leucorhinia (Fig. 83) in the rapidly expanding anal angle of a wing, the greater part of which appeared as Fig. 84, *B*, the cells having spindle-shaped bodies. We have seen them also in the anal angle of the wing of a pupa of Corydalis,

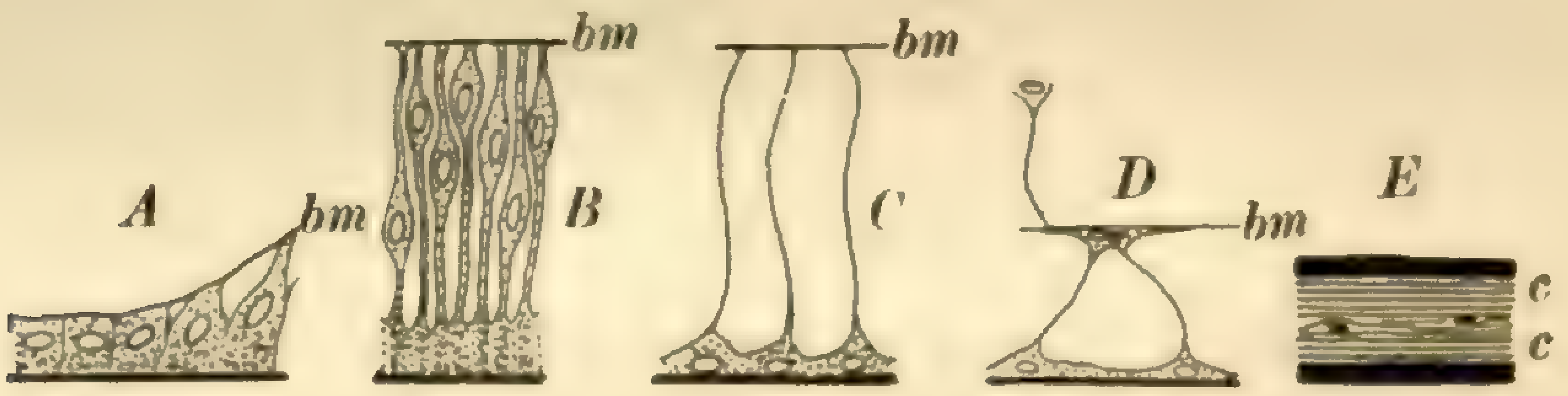

FIG. 90. — Diagram illustrating the behavior of the hypodermis during the development of an insect wing: *A*, nearly normal hypodermis; *B*, the same, after being crowded within the wing fold; *C*, the same after the first great expansion of the wing; *D*, a cell stranded upon the basement membrane; *E*, disappearance of the hypodermal cells with chitine formation.

the pre-anal area being filled with the peaked cells more characteristic of that stage.

The segregation of the hypodermis, which results in the accumulation of it around the tracheal channels and in those parts of the wing to be made strong by heavy deposits of chitine, takes place during the final stages. Some interesting illustrations of it are shown in Figs. 87 and 88, and are explained in the legends to the figures. These processes and the final disappearance of the scattered hypodermal cells, wasting themselves away in chitine formation, are the final steps in the making of the wing.

The accompanying diagram (Fig. 90) will, therefore, represent what we think may fairly be taken as typical for the behavior of the hypodermis. While this strongly suggests

[1] This is the "Grundmembrane" of Semper, which was believed by him to be formed by leucocytes during the pupal period, and, therefore, to be distinct from the middle membrane of the wing of the larva.

ontogeny, we desire explicitly to state that we believe these changes to accompany certain conditions under which cells are placed, rather than any particular stages.

IV. The Tracheæ and the Hypodermis.

After discussing these two separately, there remain a few interesting features of their correlated behavior to be noticed.

In all insect wings the two plates of hypodermis constituting the wing fold are at first separate, *i.e.*, not fused internally. At the time when the tracheæ enter the fold the two layers become approximated along lines midway between the tracheæ, resulting in actual fusion of the internal ends of the cells. We have already shown in Psocus [1] (and have seen in several other insects) the external evidences of the gradual lateral extension of the fused area to delimit definitely the channel through which the tracheæ pass. The term "cuticular thickenings" has been used hitherto to designate the pale bands along the tracheæ, and the veins to be formed here will be, of course, cuticular thickenings; but until the veins are formed (and this does not occur until the final molting) the term is inaccurate and misleading. A glance at Fig. 84, *A*, will discover that the hypodermis is in the earlier stages actually thinner here than elsewhere. It is only at transformation to the imago that the cells become aggregated about these channels and form there the dense chitine of the veins. The pale color of the bands, indicating the extent of the vein cavities when viewed by transmitted light, is doubtless due to the fact that the hæmolymph filling these cavities is more translucent than the hypodermal tissue which completely fills the wing elsewhere.

But, returning to the earlier stages, we have seen that, in wings developing externally, the hypodermis encloses the tracheæ in channels which ultimately become veins. It is now to be noted that there are often channels present which do not contain tracheæ. This is oftenest true of two large channels at the lateral margins of the wing (Fig. 84, *A*). Of these the costal remains abundantly lined with cells, which

[1] *American Naturalist*, vol. xxxii, p. 241, Figs. 11, 12.

ultimately form the strong costal vein. Its trachea is often atrophied, probably owing to the disadvantageous position of its base in relation to air supply, as we have hitherto indicated. The anal channel becomes obliterated, and the dense hypodermis of its walls dispersed by subsequent expansion of this part of the wing. In some wings in which this space persists, as in Psocus, it is occupied by the third anal trachea.

In wings developing within small hypodermal pockets, while the cells are densely crowded and while the fusion of the cells internally joining the two layers is more tardy and incomplete, the same principal channels are formed. In the Lepidoptera, though the development of their tracheæ is retarded, the temporary tracheoles pass out in tangled skeins through the original channels.

But the process of reduction of tracheæ, already begun in the lower orders, finds favorable conditions for progress in the shorter and more open wing sacs developed internally; and we find in all but the more generalized members of certain orders that the close correspondence between tracheæ and channels due to simultaneous development is again lost. Illustrations have been abundantly offered in preceding chapters; we are here offering only a suggestion as to the reason, first for this correspondence, and then for the loss of it. While the tracheæ seem at first to have been the determining factor in the venation, and while we have been able to show a gratifyingly large number of cases in which the tracheæ show the unmistakable signs of homology, and cases in which the course of the veins is still determined by them, it appears that in certain insects the tendency of the hypodermis to segregate itself and to form chitine along certain lines has become so well established as to be more or less completely independent of the tracheæ. The veins have to do in these cases with locomotion in adult life; the tracheæ, with growth and metamorphosis. The adult wing, whatever it may have been originally, has become a dry resilient plate of chitine traversed by finely adjusted supports. It would be manifestly disadvantageous for the tracheæ to follow the course of these supports, sharp angled, and often recurrent; but in wings with slight fusion between

the walls this is unnecessary. The disappearance of distinct tracheal channels has restored open competition between the tracheæ, which accounts for the more rapid disappearance of all save those most favorably situated in relation to the source of the air supply — usually only two in the most specialized insects, which still stand as representatives of the two groups of tracheæ with which we begin our series.

Fortunately for the study of homologies in insect wings, the veins had attained an arrangement so useful that it could be held by natural selection after the tracheæ had ceased to determine their position.

A CONTRIBUTION TO THE MORPHOLOGY OF PENNARIA TIARELLA McCRADY.

MARTIN SMALLWOOD.

The following paper was undertaken at the suggestion of Dr. Charles W. Hargitt, to whose kindly criticism and suggestions I am under special obligations. I am also under obligations to Dr. C. O. Whitman for courtesies at the Marine Biological Laboratory, where in part the work was done.

The purpose of the paper is an investigation of the more fundamental morphological features of this hydroid, and the development of the Medusa and origin of the sex cells.

In the work of former students of the Pennaridæ of the United States little attention was directed to other than external characters and classification. The early contribution of McCrady (10) contains the best general account that has been given of this species. L. Agassiz's (1) description of *P. gibbosa* is equally excellent for that species; yet in neither is there any reference to features of structure, which have later assumed a degree of importance not then recognized.

Methods. — For killing and staining a variety of methods was tried, but those more generally familiar gave usually the best results. Fresh Pennaria were immersed at once in corrosive-acetic, picro-acetic, Kleinenberg, and Perenyi's fluid. The best results were obtained from corrosive-acetic and picro-acetic. An excellent differential stain was secured by staining *in toto* and then extracting with acid-alcohol. Borax carmine was found to be the best stain with material fixed in picro-acetic. There seemed to be no choice of clearing agents, either xylol or turpentine was satisfactory. Excellent whole mounts of the hydroid were made by staining for a considerable time — two days — in borax carmine, then extracting with acid-alcohol. The specimens were next cleared in clove or cedar oil for

several hours. By this process the cells could be distinguished easily in any part of the hydroid where the perisarc was not too dense.

If the parts of the colony are taken up in detail, they will be found to agree on the whole with the account of Pennaridæ given by L. Agassiz (1). The main stem arises from the hydrorhiza by a slightly geniculate course, giving off branches alternately at each bend. These branches may again divide. Each branch gradually tapers from the base, bearing on the end a single hydranth of large size. About the origin of a branch there are several annulations, from eight to twelve, and several on the branch itself near its origin. Around the base of the hydranth, which is more or less bottle-shaped,—the neck of the bottle corresponding to the distal end of the hydranth,—there is a row of tentacles, twelve in number. These tentacles round off at the end much the same as in all Tubularidæ. They are termed the "long tentacles" to distinguish them from the "short tentacles," which are more or less irregularly arranged around the oral end of the hydranth. These latter are much shorter than the long tentacles, and are arranged in two whorls. They are terminated by a knob, or globular tip, which is supplied with numerous nematocysts. There is a great deal of variation in the number of the short tentacles, due chiefly to the age of the hydranth; the older hydranth having the most. The Medusæ arise from the hydranth anywhere between the rows of tentacles. They are in direct communication with the body cavity until nearly mature, when the connection becomes closed and the Medusæ are set free.

HISTOLOGY OF PARTS.

Hydrorhiza. — There will be found in the hydrorhiza a very dense, hard perisarc on the upper surface. It is more than twice as thick here as on the opposite side and much denser. The ectoderm upon this surface of the hydrorhiza presents an almost structureless appearance. It is chiefly made up of very fine granules of protoplasm. There are scattered around in this space occupied by the ectoderm several rather large oval or

roundish bodies. In their reactions to stains they show that they are probably the nuclei of the ectodermal cells. The protoplasm is more or less vacuolated; large, round vacuoles occurring scattered through it. This is especially noticeable in older hydrorhiza. In part, the appearance of all the tissues will depend largely upon the age. A young hydrorhiza differs from an old one in the degree to which degeneration of the parts has gone. On the lower side, or side adhering to the substratum, the ectoderm is only distinguishable as a narrow layer in which there are a few scattered granules. Otherwise it appears to be structureless. It is not more than one fourth as thick here as it is on the upper side. In the young hydrorhiza, which is creeping over the eel-grass, the ectoderm contains cells which are very similar to the cells in the endoderm. The same is also true of the ectoderm in the upper side during this stage. The endoderm exhibits a cellular structure, although the cell walls are very indistinct. The cytoplasm has been broken up into small, round bodies, and the nuclei are much smaller here than elsewhere in the endoderm of the hydroid.

Hydrocaulus.—The perisarc in section in a young hydrocaulus is semi-transparent or opaque. It is thicker than when mature. In the mature hydrocaulus the perisarc is thinner, and is darker adjacent to the ectoderm than in the hydrorhiza. The ectoderm shows signs of cellular structure in the position of the nuclei and the presence of cell walls in places. As the hydrocaulus is examined nearer the hydranth the nuclei are found to belong to definite cells with definite cell walls. If the endoderm is examined in a typical section, it is very materially different from the endoderm in the hydrorhiza. The nuclei are larger and more prominent. The cytoplasm is homogeneous except for the presence of food particles.

Hydranth.—The hydranth is wholly devoid of perisarc, which terminates somewhat abruptly just below it. The cells of the ectoderm possess distinct nuclei and cell walls, but only a small amount of cell substance, judged by the reaction to stain. The cells of the endoderm are arranged in the hydranth in groups, usually there are four of them. The most conspicuous of these are the digestive cells. They are much larger than the other

cells of the endoderm, and project out into the cavity about half of their length. The nuclei are of different sizes, according to their position in the endoderm. Some of the nuclei found in the digestive cells are twice as large as those occurring in the other cells. Between these four groups of specialized digestive cells the endoderm is quite regular.

Mesoglea. — The mesoglea presented the same appearance and was of the same thickness in each region.

Origin and Development of the Medusa.

The Medusa takes its origin from the hydranth, between the rows of tentacles. There is no definite region on the hydranth from which the buds arise. However, they are more abundant near the base of the second or "longer tentacles." The number of buds which may be found upon the hydranth at one time varies. In case the hydranth is giving origin to male Medusæ there may be four or five, but usually two or three are all that will be found. The hydranths which give rise to female Medusæ generally give off only one. One exception was noted to this, but it holds true in the majority of cases. When a hydranth gives origin to more than one Medusa, they will not be in the same stage of development. I have found the two extremes on the same hydranth — the buds just forming and the mature Medusæ ready to be set free, together with several intermediate stages.

The Medusa bud arises as a simple evagination of the hydranth. The bud is hollow and supplied directly with nourishment from the circulating currents of the hydranth. As a bud becomes larger and longer, many interesting changes take place. In the mature Medusa the parts correspond to the type Hydromedusa, yet the manner in which the several layers originate is very different. Agassiz states that Pennaria develops its Medusæ in the same way as Coryne and Bougainvillia do (2). While the several parts are the same in Coryne and Pennaria, yet their origin and development are very different. The first sign of the formation of the Medusa bud is shown by a thickening of the cells of the ectoderm. This change produces a

slight papilla-like elevation on the side of the hydranth. The endoderm goes through a similar process, though not so extensive. There is no open cavity in the bud at this stage (Fig. 1). The space is entirely filled by the cells of the endoderm. The cells of the ectoderm have changed in appearance very much from those adjacent to them in the hydranth proper. These cells are the chief seat of activity, as all of the more important changes, which occur from now on, take place in them. The cells of the endoderm are secondary in importance. These results are confirmatory of the work of Dr. F. Braun (3) and contrary to that of Arthur Lang (4). The cellular structure in the ectoderm has practically disappeared at this early stage, and we have a large number of nuclei scattered in the cytoplasm. These nuclei are large and prominent. They are nearly spherical in shape. There is a very definite nucleolus, usually centrally located, which stains very deeply. The nucleoplasm has a few chromatin fibres irregularly arranged. This condition of the ectoderm is brought about in the following manner. The ectoderm, more especially at the distal end, begins to grow by a proliferation of cells, so that the thickening of the ectoderm, which takes place in the first stages in the development of the Medusa, is not so much a thickening as it is an increase in the number of cells in this region. The bud begins now to elongate until it has become partly differentiated from the hydranth (Fig. 2). The endodermal cells are smaller than at the earlier stage and enclose a cavity. The proliferation of the cells of the ectoderm continues until the bud has become about half full. It would be more accurate to say that the nuclei become more numerous than that the cells increase, because there is no indication of cells other than the presence of the nuclei and the cytoplasm in which they are imbedded. This may, however, be due to the fact that an absence of cell membrane makes difficult and indistinct the cell boundaries. While this change has been taking place, the Medusa has grown larger and longer. The

FIG. 1.

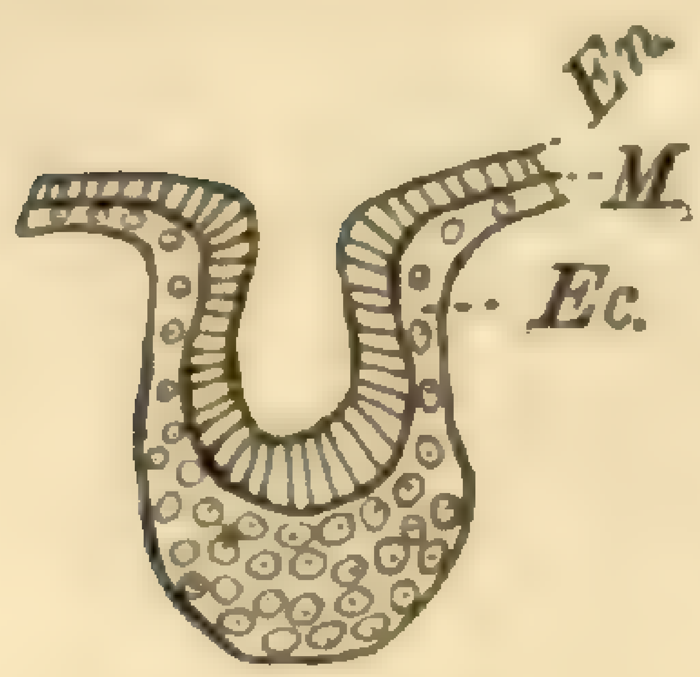

FIG. 2.

filling up of the distal end of the bud with these prominent nuclei and the surrounding cytoplasm at first forces the endoderm back, but it soon begins to force its way down through these cells in the center and around the margin of the bell. The prolongation of the cells which grow down in the center is to become the manubrium. Jointly with this formation, the endoderm is sending a layer of cells around the bell close to the ectoderm (Fig. 3). As these cells grow around, they cut off the interior mass of ectodermal cells from the outside layer, as shown in Fig. 4.

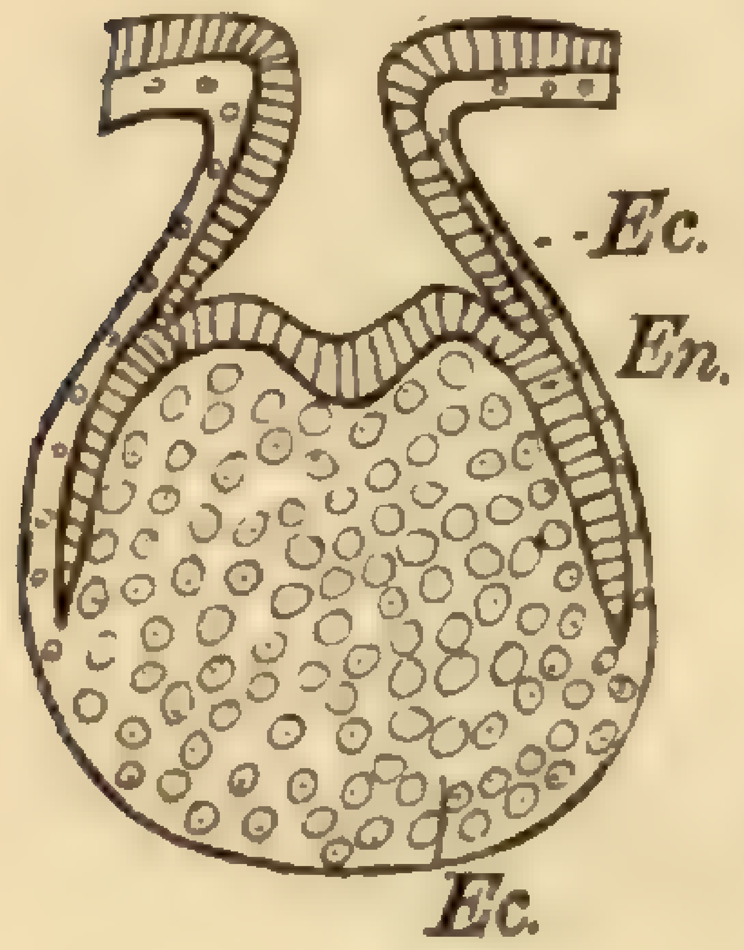

FIG. 3.

This layer of endoderm now becomes the second layer in the umbrella of the Medusa. All of the cells between the manubrium and this new layer are of ectodermal origin. The cells adjacent to this layer of endoderm show a tendency to arrange themselves in a row, the nuclei of which are smaller than those from which they have been derived. By the time the endoderm has grown around, completely separating the outer layer of ectoderm from the cells within, this row of cells has become a definite layer. This layer becomes now the lining of the bell. When the layer is completely formed, the nuclei are much smaller than they were when the layer was forming. This larger layer is more prominent in *P. cavolini;* the cells are larger and the nuclei more numerous. The mass of cells formed between the bell and the manubrium is to give rise to the

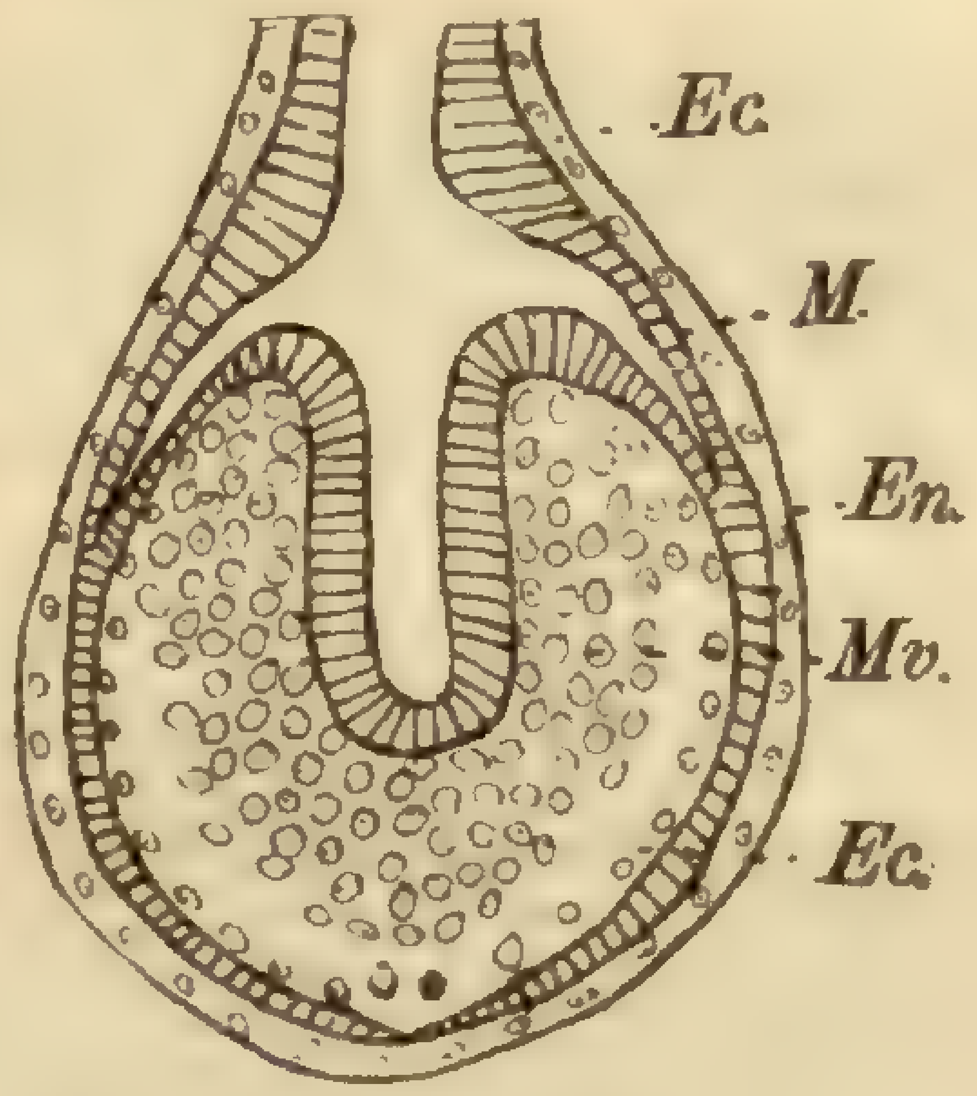

FIG. 4.

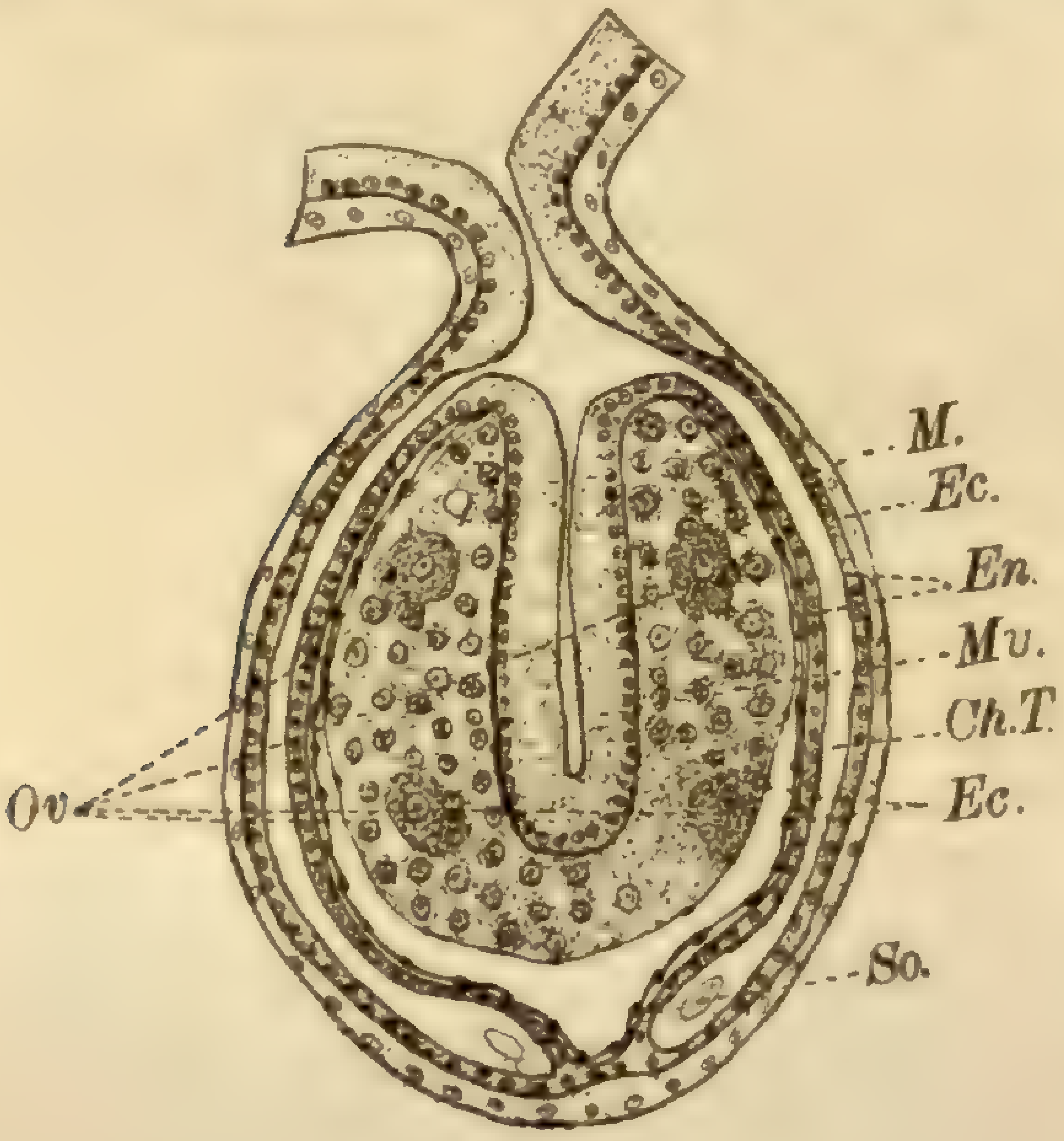

FIG. 5.

reproductive elements. Another layer is yet to be formed. As the reproductive elements continue to develop, a thin delicate membrane is produced which seems to be a differentiation from these cells (see Fig. 5). In the male it is always very delicate, while in the female it becomes more prominent. The manubrium has grown through the cells of the ectoderm while these other changes have been going on, and divides them into two equal parts when seen in section. The cells of the manubrium become differentiated until they present the same appearance as the endodermal cells in the hydranth. The cells of the endoderm which form the second layer of the bell undergo the following changes: the endoderm becomes much thicker in four regions equally distant from each other. This thickening gives rise to the chymiferous tubes by a process of cleavage and not by a fusion of two layers, as is the usual way. The splitting begins at the point where the endoderm turns in from the bell to form the manubrium (Figs. 4 and 6). This process is continued until there is a canal extending down to the lower margin of the Medusa. It is much larger at the lower end and extends farther around than do those same canals halfway up. The endoderm between the chymiferous tubes has not undergone any perceptible change during their growth. In *P. cavolini* the chymiferous tubes are much larger than in *P. tiarella*, probably because they are functional for a longer time. In this hydroid the Medusæ are not set free and these tubes are still found in the mature Medusa.

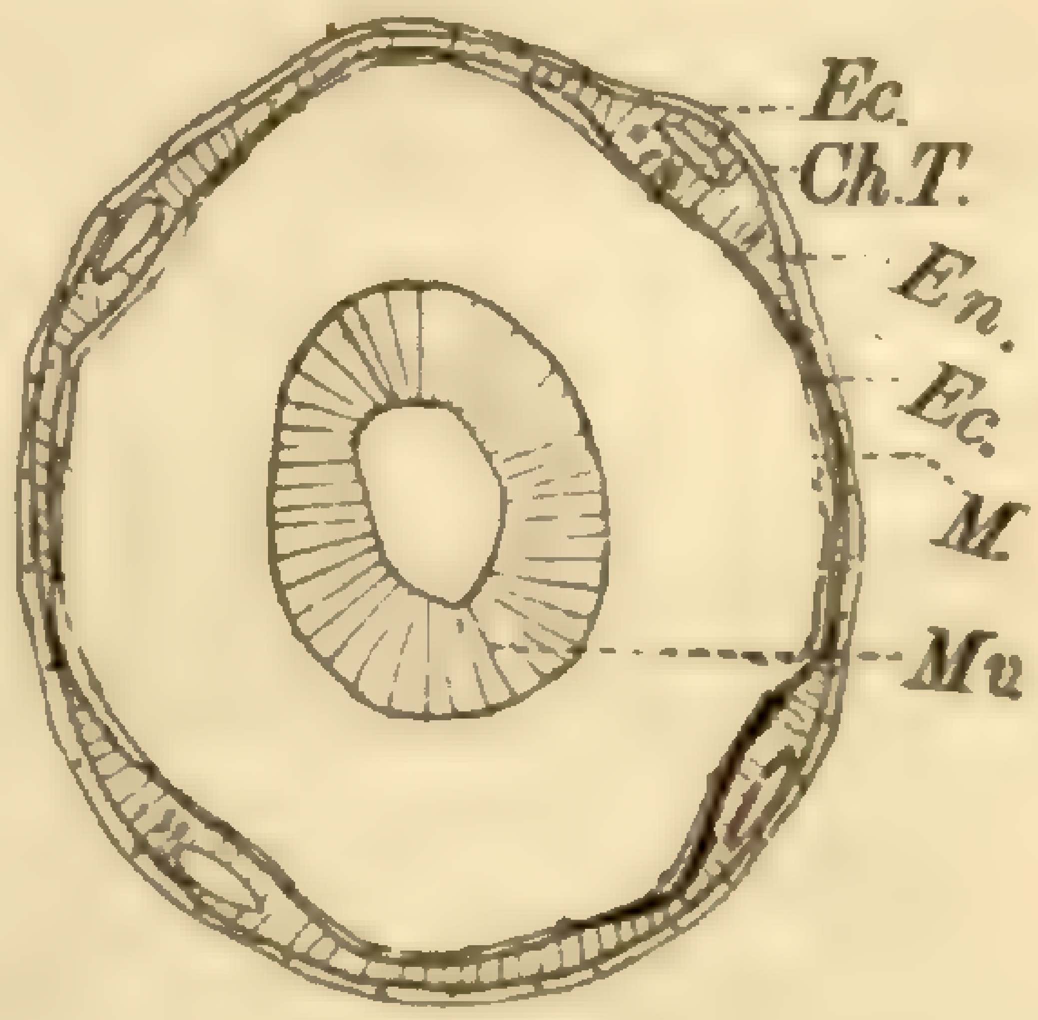

FIG. 6.

The tentacles are rudimentary and never develop. They consist simply in a thickening of the outer layer of the ectoderm. They are found at the end of the chymiferous tubes and are four in number.

The sense organs originate from the endoderm at the blind end of the chymiferous tubes. They do not show any very definite structure. In one there could be distinguished a central portion, which was more transparent than the rest, and

it did not stain so deeply. Many fine filamentous threads extended from the sense body to the walls of the tube. These threads seem to suspend it in the center. The fact that they are in such a rudimentary condition, and less highly specialized than in other Medusæ, would tend to show that their function is of a simple character, possibly used more as balancing organs than anything else. After the chymiferous tubes are formed, the further changes which take place are chiefly confined to the reproductive elements and will be explained in speaking of their development.

The description of the external morphology of the Medusa has been given so accurately by Agassiz that we can do no better than quote his exact words: "The Medusa of *P. tiarella* is one of the most remarkable of our naked-eyed Medusæ. As in the Sarsiadæ, the Medusa bud is formed among the tentacles. The chymiferous tubes never have the extraordinary thickness which is noted in Sarsia, and the cavity of the bell is hollowed out at an earlier period; the Medusa bud gradually becomes more elongated, and when mature is about one-sixteenth of an inch long." The Medusa full of eggs measures 1.2 mm. long and .7 mm. wide. Free of eggs, .9 mm. long and .5 mm. wide. He continues by saying that "the walls of the spherosome are so thin that the Medusa will often assume a quadrangular or octagonal outline with deep indentations between the chymiferous tubes. Large white eggs fill the cavity of the bell; as they increase in size they give the Medusa an opaque milky appearance. The walls of the spherosome become thinner and thinner, and when the Medusa bud has attained its full development and is ready to be separated, the walls become so thin that the Medusa is almost always distorted, either on one side or the other, by bunches of spermaries or by the eggs which have reached such a great size that four or five of them completely fill the inner cavity." The eggs are large white bodies, very opaque, .33 mm. in diameter. When they begin to segment, they look much whiter, and one can distinguish the segmenting egg by the unaided eye (2).

The opening through which the reproductive elements are to be expelled is formed after the Medusa is mature. More obser-

vations upon the Medusæ will be necessary after they become free, in order to ascertain whether a true mouth is formed. In the layers of the mature Medusa there is scarcely any cellular structure evident. The cytoplasm in the cell has disappeared, and the only structural feature present is a round body, which stains very deeply and looks as if it might be a nucleus in a very reduced condition. The chymiferous tubes have entirely disappeared except where the sense organs are found. That these tubes are functional in some of the earlier stages seems reasonably sure, because food has been found in them which was of the same character as that found in the hydranth. The connection between the hydranth and the Medusa becomes reduced with the growth of the Medusa, and finally breaks when the conditions are favorable.

The Medusæ of Pennaria seem to be in a degenerate condition, and in a sense occupy an intermediate stage between the free-swimming Medusæ and those that have lost all resemblance to this stage and are never free, as in Clava, Eudendrium, and others. The two most important reasons for thinking the Pennaria Medusæ degenerate are: first, the change which the chymiferous tubes undergo; and, second, the fact that there is no apparent mouth or circumferential canal. While the evidence is not conclusive, yet it is very suggestive and may throw some light upon other forms.

Oögenesis.

While considering the development of the Medusa, it was stated that the cells originating from the ectoderm, and which filled up the cavity between the manubrium and the bell, were destined to give rise to the reproductive elements.

If the cells are studied in such stages as are represented by Figs. 3 and 4, they will be found to be large and to possess large prominent nuclei. These cells continue to enlarge for a time, during which the cytoplasm becomes denser and more granular close to the nuclei. These may all be considered primitive ova at this stage. Five or six of these, at the most, are all that may mature into eggs. If the various cells

are carefully scrutinized at this period, it will be observed that some of them have more cytoplasm than the adjacent cells (Fig. 5). These few cells, which I have termed ova centers, become mature by the continuous increase of the cytoplasm, which is accomplished by the thrusting out of protoplasmic processes which surround the adjacent cells and absorb them into the developing egg (11). The nucleus appears to be in a state of degeneration in most of the cells adjacent to the egg. Some of the nuclei have their membrane only, while others retain all of the parts of the nucleus even after they have been taken into the egg (Fig. 7). Here some cells have just been taken into the main mass of cytoplasm. The various stages in the degeneration of the nucleus are also evident. Not all of the primitive ova are thus consumed; some will be found which have not been utilized at all. They have simply remained undeveloped and are found scattered among the mature eggs. They seem not to serve any purpose in egg formation, but represent remnants of undeveloped and unused cells.

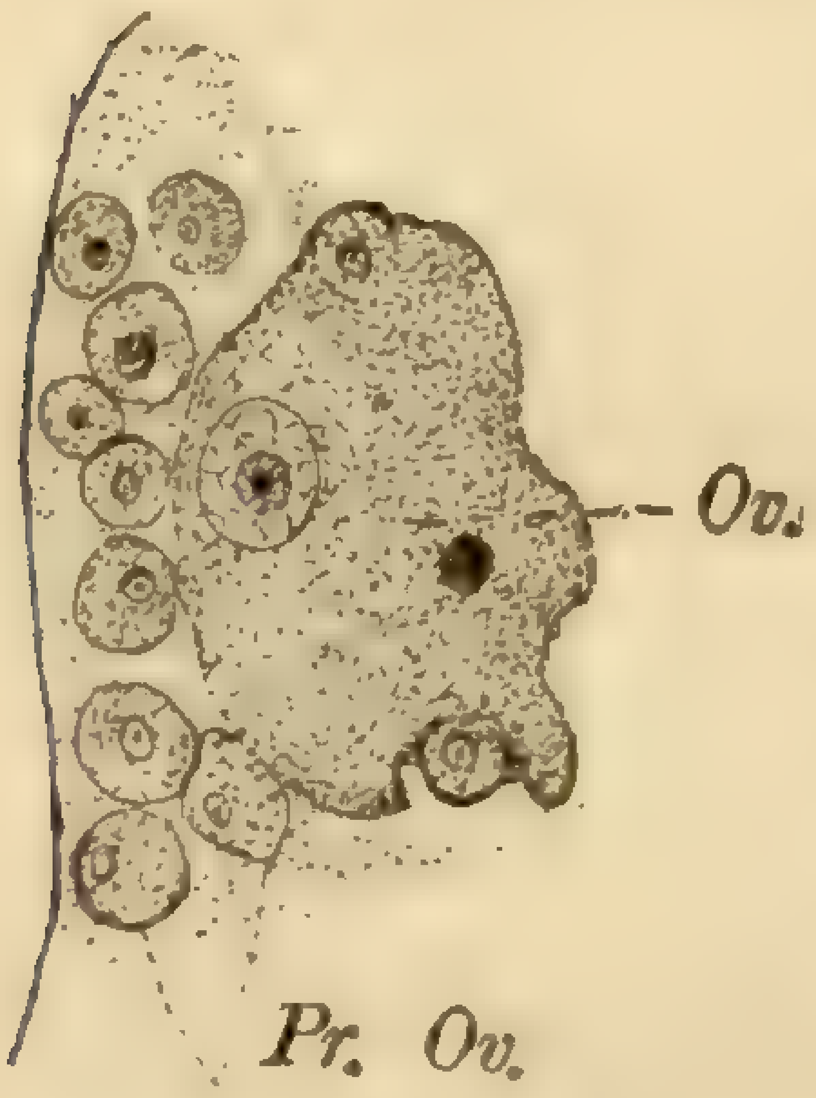

FIG. 7.

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REVERSAL OF CLEAVAGE IN ANCYLUS.

SAMUEL J. HOLMES.

THE fact discovered by Crampton that in Physa, a genus of sinistral gasteropods, the direction of the early divisions of the ovum is just the reverse of the corresponding cleavages in the dextral forms suggests, as Crampton pointed out, that there may be some correlation between the reversed cleavage of the ovum and the reversed asymmetry of the adult. The reversed asymmetry of Physa is shown, not merely by the sinistral coil of the shell, but also by the arrangement of the organs of the body. In most gasteropods the anal and genital orifices open on the right side of the body, but in Physa their position is on the left side; and the lung cavity, normally on the right side in the pulmonates, opens on the left in Physa. In fact, the asymmetry of the sinistral form seems in all respects just the reverse of that of the dextral forms. In Planorbis, a genus in which there is a reversal of the position of the organs of the body, although the shell is often coiled in one plane or even dextral (pseudo-dextral), the cleavage of the ovum is of the same reversed type as in Physa. This reversal is shown as early as the second cleavage of the egg which leads to the four-cell stage. Even before there is any elongation of the dividing cell, or any external indication of cleavage whatever, the direction of the approaching division is shown by the inclination of the nuclear spindles. This early indication of the direction of division is shown in the two-cell stage in Crepidula, Limax, Lymnea, and Amphitrite, but in all these cases in which the cleavage is of the dexiotropic or normal type the inclination of the spindles is the reverse of that in Physa and Planorbis. As a consequence of this oblique division, we have probably in all forms with typical spiral cleavage a four-cell stage in which two of the cells lie at a somewhat lower level than the other two and meet in a cross furrow at the vegetal pole. The lower

part of the first cleavage plane, when viewed from the animal pole, bends at this cross furrow in the dextral forms, first to the right and then to the left; in the sinistral forms the bend is first to the left and then to the right. When we know, therefore, between which cells the first cleavage plane runs, the four-cell stage, produced by reversed cleavage, can be distinguished at a glance from a four-cell stage of the normal type. The one is the mirrored image of the other.

It is a remarkable fact that, not only in all dextrally coiled gasteropods whose cleavage has been carefully studied, but in many groups characterized by a typical bilateral symmetry, such as the lamellibranchs, Amphineura, annelids, and polyclades, the cleavage is uniformly dexiotropic. The two sinistral gasteropods, Physa and Planorbis, form, I believe, the only instances in which, up to the present time, a reversed spiral cleavage is known to occur.

It was with the desire of obtaining more data bearing upon this subject that I was led to study the cleavage of Ancylus, the common fresh-water limpet. In this genus the coil of the shell is almost entirely lost, and in some forms the shell appears to possess an almost perfect bilateral symmetry; but in many species of the genus the animal is truly sinistral, as the heart, lung, and anal and genital openings lie on the left side of the body. The genus contains both dextral and sinistral forms and has been divided into several subgenera, Ancylus proper containing the sinistral species, while the subgenus Acroloxus comprises only those that are dextral. The species studied, *Ancylus rivularis* Say, belongs to the sinistral group and is found in considerable abundance in a small lake near Ann Arbor, Mich. Specimens taken September 12, and kept in glass dishes in the laboratory, deposited eggs in the sides of the vessel, but not in any great number. The eggs are laid in minute, transparent, colorless capsules, each capsule, unlike that of the European species *A. fluviatilis*, containing but a single egg. The capsule is covered by a membrane and contains a semi-fluid, gelatinous substance in which the egg floats similar to that which surrounds the egg of Physa or Lymnea. It is a difficult matter, on account of its small size and the toughness of the membrane,

to get the egg out of the capsule without injury, and the chance of losing it in the process of fixation, staining, etc., before it is safely mounted, is very considerable, so that no attempt was made to carry the cleavage very far. At the first cleavage the egg divides into two equal cells, which round off in the usual manner and then become more closely approximated shortly before the division into four cells. The eight-cell stage is formed by the unequal division of the four cells, each cell giving off a smaller clear cell at the animal pole. This cleavage is an oblique one, the daughter cells lying in the angles between the larger cells. The smaller cells do not lie exactly midway between the larger ones, but more nearly over the cells from which they arose. The next cleavage takes place in the four larger cells or macromeres, and, as indicated in Fig. 2, the direction of cleavage is shown to be in a right-handed spiral by the inclination of the spindles — just the reverse of the corresponding cleavage in the unreversed type. The cleavage of the egg was not followed beyond this point, but it is very probable that the subsequent divisions would show the same reversal. In Physa, according to Crampton, every division as far as the twenty-eight-cell stage is the reverse of the corresponding division in the closely allied genus Lymnea, and in Planorbis, in which I have followed the cleavage in detail to beyond the 150-cell stage, the reversed type of cleavage holds, except in one or two divisions, as far as the cleavage is of a determinate spiral character.

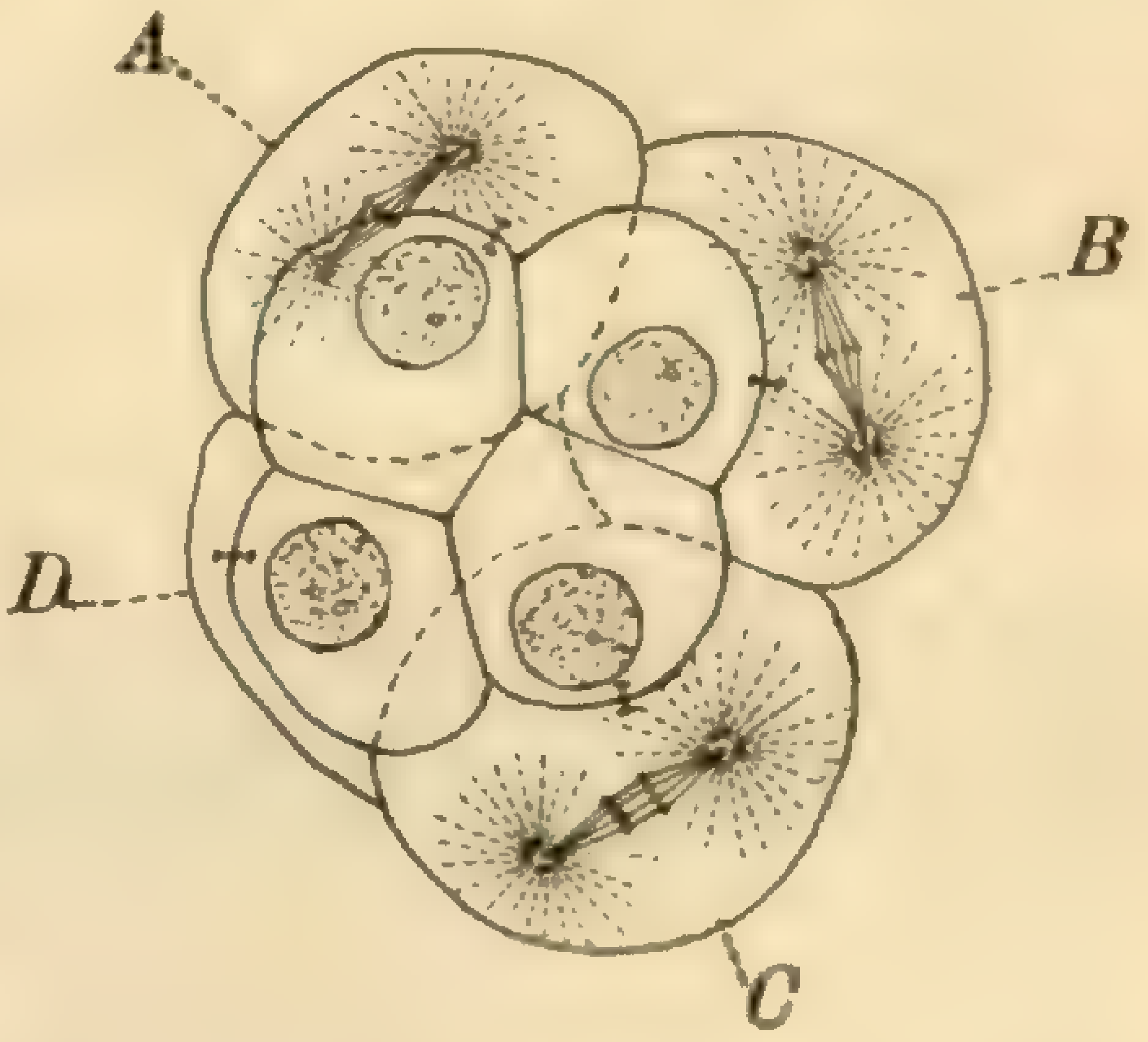

FIG 1. — Eight-cell stage seen from the animal pole.

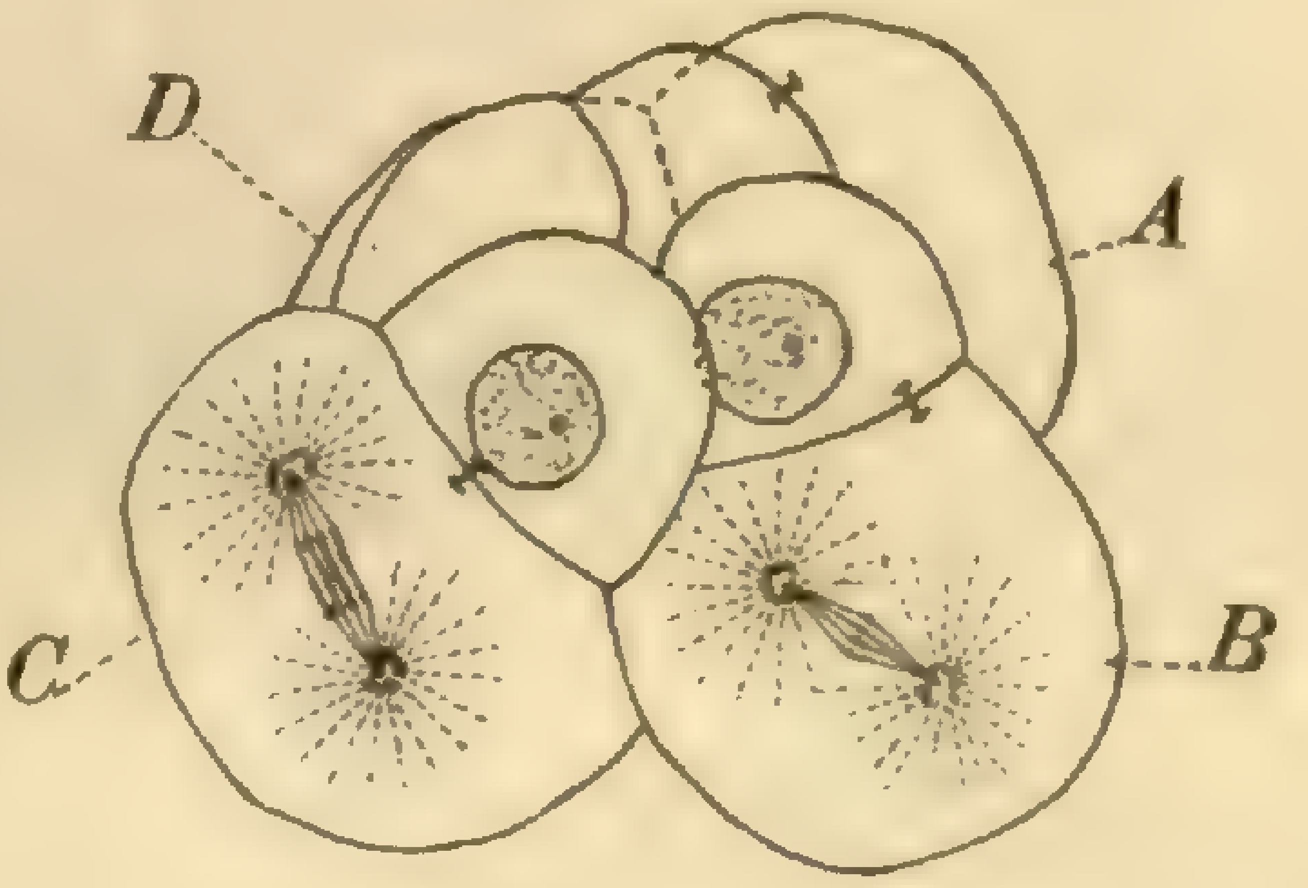

FIG. 2. — The same egg seen obliquely, showing the dexiotropic inclination of the spindles in the dividing macromeres. The cell *C* has begun to elongate.

It is one of the striking features of the cleavage of many mollusks and annelids that certain cells of the upper side of

the egg become so arranged as to produce the appearance of a cross, the center of which lies at the apical pole. It was found by Conklin that the arms of the cross in Crepidula are not exactly meridional in position, but have a slight dexiotropic twist. This twist Conklin considered as an expression of the dexiotropic cleavage of the egg, and the fact that the same inclination of the arms of the cross has been found by Heath in Ischnochiton, a form with the same type of cleavage, tends to confirm this view. In Planorbis, on the other hand, the inclination of the arms of the cross is very plainly læotropic, and this twist may be seen as late as the end of the period of gastrulation. A careful comparison of the genesis of the arms of the cross in these forms would convince any one, I believe, that the different directions of the inclination of the arms is correlated with the different types of cleavage. As a result, therefore, of reversed cleavage a considerable portion of the embryo becomes subjected to a torsion in a direction different from that which occurs in the normal forms. It does not seem possible in Planorbis to connect directly this torsion of the cross with the sinistral organization of the animal, for this structure disappears before the asymmetry of the embryo is manifest. However, the fact that reversal of cleavage shows its effects as late as the gastrula stage lends considerable support to the view that it may stand in some causal relation to the reversed asymmetry of the adult.

In Crepidula, Conklin has succeeded in tracing the beginning of the asymmetry of the embryo to the division of one of the cells of the entoderm. The time and direction of this cleavage were found to give the initial twist to the rudiment of the intestine. "If," says Conklin, "the initial asymmetry is caused in Physa, as in Crepidula, by the asymmetry of the cells *5C* and *5D*, then it is easy to see how this reversal of cleavage stands in a causal relation to the reversed asymmetry of the adult." In Planorbis the corresponding divisions result in the formation of very small cells instead of large, yolk-laden ones, as in Crepidula, and do not seem to exercise any influence in determining the asymmetry of the embryo. The cells of the entoderm become very numerous (over thirty) and of small size

before gastrulation occurs, and it seems impossible to connect the asymmetry of the adult with any of their divisions. The læotropic inclination of the arms of the cross in Planorbis is probably the expression of a torsion that affects, to a certain extent, a large part of the segmented ovum, and the reversed asymmetry of the adult may depend upon this general twist, rather than the reversed division of any of the cells of the entoderm. It is not improbable that the asymmetry of the animal may first manifest itself, as the results of various investigations indicate, in different parts of the embryo in different forms.

The reversal of cleavage in Ancylus has, I believe, a special significance from the fact that the left-handedness occurring in this genus has, in all probability, arisen independently of that of Physa and Planorbis. It may, indeed, be doubted whether the reversed asymmetry of the latter genera is due to their descent from a common sinistral ancestor; but, however this may be, it is scarcely possible that Physa, Planorbis, and the sinistral species of Ancylus all belong to one group which branched off from the dextral species of Ancylus and the other pulmonates. As is well known, we have sinistral individuals occurring as occasional variations among dextral forms, and in the genus Fulgur and in several genera of the terrestrial pulmonates there are well-established dextral and sinistral species. Analogous reversals of asymmetry occur in other groups of animals, such as the flounders, certain nematodes, and many crustaceans, and there appears to be no great improbability, *a priori*, in supposing an independent origin of left-handedness in Ancylus; besides, any other supposition would involve us in improbable phyletic derivations. The chance that the association of reversed cleavage with reversed asymmetry in the gasteropods is a mere coincidence is very much lessened by the circumstance that the same association obtains where the reversed asymmetry has been independently acquired. It would be a matter of interest to ascertain if the cleavage of the dextral species of Ancylus were of the normal type, and if the right-handed and left-handed species of Fulgur and the terrestrial pulmonates, Pupa, Bulimnus, and

Clausilia, have respectively a normal and reversed cleavage. So far as the facts are known at present, they seem to justify the view that the reversed asymmetry of the sinistral gasteropods owes its origin to a reversal of cleavage of the egg.

University of Michigan,
October 13, 1899.

SYNOPSES OF NORTH-AMERICAN INVERTEBRATES.

V. Fresh-Water Ostracoda.

C. H. TURNER.

The Ostracoda form a well-defined division of the Entomostraca. They resemble the Lamellibranchiata in having the body enclosed in a bivalve shell. This peculiarity, which causes many a novice to mistake the Ostracoda for small Mollusca, is merely a superficial resemblance; for, although the structure of the enclosed animal is quite primitive, yet it is decidedly crustacean.

The body always bears seven pairs of articulated appendages. The first five of these are head appendages; but, in different groups, either one or all of the last three pairs of these cephalic appendages may be modified for locomotion. The last two pairs belong to the body and are usually known as feet. In some cases (Cypris), however, the last pair of feet is not used for locomotion. In most cases the abdomen terminates in a pair of appendages which resemble legs.

Handicapped by a comparatively heavy shell, the Ostracoda make, as a rule, very poor swimmers. Near the surface in deep waters these creatures are rare. Shallow ponds and marshes are their favorite haunts, but they are also found in rivers and at or near the bottom of lakes. Comparatively speaking, some forms swim quite well (Cypria, Cyclocypris, Cypridopsis), while others do not swim at all, but creep along the bottom or up the stems of plants, or else burrow in the mud or sand (Erpetocypris, Candona).

In the South, specimens may be collected at almost any time of the year, but the spring and fall are the best collecting seasons. In the North they may be collected from early spring to late fall, but spring and fall seem to be the best collecting seasons.

The literature of the Ostracoda is legion, but all known American fresh-water forms are described and figured in the following publications. The first two also contain a fairly complete bibliography up to 1896.

HERRICK, C. L., and TURNER, C. H. Synopsis of the Entomostraca of Minnesota, Copepoda, Cladocera, and Ostracoda. *Geol. and Nat. Hist. Survey of Minn.* 1895.

SHARPE, R. W. Contribution to a Knowledge of the North-American Fresh-Water Ostracoda included in the Families Cytheridæ and Cyprididæ. *Bull. Ill. State. Lab. Nat. Hist.* Vol. iv. 1897.

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In compiling the following key free use has been made, not only of my own manuscript notes and published papers, but also of the published works of Brady, Vávra, and Sharpe.

The key includes all fresh-water genera known to me, whether they occur in America or not. An attempt is made to incorporate all known American species. A few European forms not yet found in America are included. All such forms are marked with an asterisk (*).

KEY FOR THE DETERMINATION OF THE AMERICAN FRESH-WATER OSTRACODA.

A. Second antennæ unbranched . . . . PODOCOPA

AA. Second antennæ two-branched.

- *B.* One branch rudimentary and immobile . . MYODOCOPA*
- *BB.* Both branches developed.
  - *C.* Basal portion of the first antennæ geniculate, and the branches of the second antennæ flattened PLATYCOPA*
  - *CC.* Basal portion of the first antennæ not geniculate, and the branches of the second antennnæ not flattened CLADOCOPA*

TRIBE PODOCOPA.[1]

A. Last pair of legs bent backwards within the shell and not used for locomotion . . . . CYPRIDIDÆ (I)

[1] The marine genera Aglaia, Argillœcia, Anchistrocheles, Cyprois, Paracypris, and Pontocypris are not included in this key.

* Contain no fresh-water forms.

AA. Last pair of legs directed downwards and used for locomotion.
B. Mandibles slender and styliform . . . PARADOXOSTOMIDÆ*
BB. Mandibles not styliform and toothed at the extremity.
C. Second maxillæ pediform.
D. Caudal rami obsolete, forming two rounded, setiferous lobes . . . . CYTHERIDÆ (II)
DD. Caudal rami well developed but small . BARDIIDÆ*
CC. Second maxillæ not pediform but provided with a pediform palp . . . . DARWINULIDÆ (III)

I. FAM. CYPRIDIDÆ.

A. Second foot terminates with a cylindrical joint that bears two backwardly directed setæ.
B. Second foot of both male and female six-jointed. No branchial plate attached to the second maxillæ . . Notodromas 11
BB. Second foot of the female usually five-jointed and of the male six-jointed. The second maxilla bears a branchial plate.
C. Branchial plate feebly developed in the form of two pectinated setæ.
D. Eye present . . . . Candona 1
DD. Eye absent . . . . Typhlocypris 15
CC. Branchial plate developed in the form of three pectinated setæ . . . . Candonopsis 2
CCC. Branchial plate developed in the form of six pectinated setæ.
D. Palp of second maxilla rudimentary Ilyocypris 10
DD. Palp of second maxilla normally developed.
E. Terminal joint of the second foot one third as long as the fourth joint or shorter Cypria 4
EE. Terminal joint of the second foot two thirds as long as the fourth joint . . Cyclocypris 3
AA. Second foot terminates with a beak-shaped joint that bears one backwardly directed claw.
B. Caudal rami rudimentary.
C. Flagellum-like . . . . Cypridopsis 6
CC. With lamellar base and long seta . Potamocypris 12
BB. Caudal rami normally developed, cylindrical, terminating in two claws.
C. Natatory setæ of the second antennæ not reaching to the base of the terminal claws . . . . . . Scottia 13

CC. Natatory setæ of the second antennæ reaching to the base, but not to the tips of the terminal claws; claws of abdominal rami smooth or feebly denticulate
Erpetocypris 9

CCC. Natatory setæ of the second antennæ reaching to or slightly beyond the tips of the terminal claws.

D. Dorsal setæ of caudal rami rudimentary or absent and the terminal claws of the abdominal rami coarsely denticulate . . . . Stenocypris 14

DD. Dorsal setæ of caudal rami normally developed.

E. Parthenogenetic . . . . Cypris 8

EE. Sexual . . . . Cyprinotus 7

BBB. Caudal rami exceedingly large and elongated, natatory setæ of both pairs of antennæ well developed, palp and masticatory lobe of first maxillæ narrow . . . . . . Cypricercus 5

1. Candona Baird, 1850.

Antennæ of female five-jointed, of the male six-jointed. Natatory setæ absent. Two characteristic sensory setæ occur between the fourth and fifth joints of the second antennæ of the male. Branchial plate of the second maxilla composed of two unequal pectinated setæ, which are attached to the basal portion of the maxilla. The palp of the second maxilla of the female is two-jointed and terminates with three pectinated bristles; of the male is unjointed and differs in shape from that of the female. Second foot either five- or six-jointed, terminating in two unequally long, backwardly directed setæ and one forwardly directed seta. Caudal rami strong, bearing two terminal claws, the dorsal seta of the ramus usually quite remote from the claws. At the origin of the rami the dorsum of the body terminates in a short seta. Eye small. Males usually more common and larger than the females. Seven rows of chitinous spines arranged around the central cylinder of Zenker's organ. Cannot swim, but creeps along the bottom, or burrows in the mud or sand.

a. One of the shorter setæ of the tip of the second foot sharply reflexed . . . . *C. reflexa* Sharpe

aa. Setæ at the tip of the second foot not reflexed.

b. Length of shell about 1.50 mm., shell inequivalve, second foot six-jointed . . . . *C. crogmani* Turner

bb. Length of shell between 0.90 mm. and 1.25 mm.

c. Caudal rami curved, second foot six-jointed.

d. Terminal claws of caudal rami stout
C. fabæformis Fischer

dd. Terminal claws of the caudal rami slender, spines on the first mandibular process of first maxilla not toothed.

e. Color white . . . . . *C. acuminata* Fischer

ee. Color greenish yellow variegated with blotches of brown . . . . . *C. delawarensis* Turner

cc. Caudal rami not curved.

d. Terminal claws of rami S-shape . *C. sigmoides* Sharpe

dd. Terminal claws not S-shape, the longest one-half as long as the ramus . . . . . *C. recticauda* Sharpe

2. Candonopsis Vávra, 1891.

Second antennæ similar to those of Candona. Mandible bears an extraordinarily long palp. Branchial plate of the second maxilla composed of three plumose bristles. Caudal rami slender, usual dorsal seta absent.

No species of this genus has yet been found in America.

3. Cyclocypris Brady and Norman, 1889.

First antennæ seven-jointed. Second antennæ five-jointed in female, six-jointed in male, no olfactory organ on the fourth joint. Natatory setæ of the second antennæ reach far beyond the tips of the terminal claws. Palp of both the mandible and first maxilla normally developed. The second maxilla bears a branchial palp and a plate. This branchial palp in the female is unjointed ; in the male it forms a hooked prehensile organ. Last joint of second foot unusually long, being two thirds the length of the fourth joint. Zenker's organ resembles the corresponding organ of Cypria. Vas deferens long and convoluted, copulatory organ quadrangular. Males numerous.

a. Front edge of caudal ramus about twice as long as its terminal claw *C. lævis* O. F. M.

aa. Front edge of caudal ramus about two and a half times the length of the terminal claw.

b. Terminal claws of caudal rami strong and much bent *C. forbesi* Sharpe

bb. Terminal claws of caudal rami slender and not bent *C. modesta* (Herrick)

aaa. Front edge of caudal ramus about three times the length of the terminal claws. Terminal claws strong, nearly straight, weakly bent near the tips . . . . *C. globosa** Sars

4. Cypria Zenker, 1854.

Second antennæ of the female five-jointed, of the male six-jointed. Distal extremity of the fourth joint of the second antenna bears two olfactory setæ. Natatory setæ of the second antennæ extend far beyond

the tips of the terminal claws. Mandibular palp much elongated. Palp of the first maxilla strongly developed. Second maxilla bears a well-developed branchial plate. In the female the palp of the second maxilla is unjointed and terminates in three setæ; in the male it forms a hooked prehensile organ, and the right and left palp of the male are dissimilar. Caudal rami are robust and the dorsal setæ are situated about midway of the outer border. Eye large. Muscle impressions four. The center of Zenker's organ surrounded by seven whorls of chitinous setæ. The upper part of the organ forms a blind sac, the lower terminates in the funnel-shaped origin of the vas deferens. Copulatory organ triangular. Males numerous.

a. Terminal short setæ of the second foot approximately equal.
- *b.* Terminal short setæ of the second foot about two times the length of the last joint. Left valve with a dorsal flange; right valve with row of tubercles anteriorly and ventrally — *C. pustulosa* Sharpe
- *bb.* Terminal short setæ of the second foot about as long as the terminal joint.
  - *c.* Terminal claw of the caudal ramus half the length of the ramus.
    - *d.* Shell equivalve.
      - *e.* Covered with a close reticulum of subparallel lines. Length 0.54 mm. to 0.64 mm. — *C. exculpta* (Fischer)
      - *ee.* Covered with irregularly scattered large puncta. Length 0.55 mm. to 0.58 mm. — *C. ophthalmica* (Jurine)
  - *cc.* Terminal claw of caudal ramus three fifths the length of the ramus or longer.
    - *d.* Shell inequivalve, valves glossy, finely pubescent. Length 0.46 mm. to 0.52 mm. — *C. inequivalva* Turner
    - *dd.* Shell equivalve, surface smooth, sparsely hairy. Length 0.69 mm. . . . . *C. dentifera* Sharpe

aa. Terminal short setæ of the second foot evidently unequal.
- *b.* Shell covered with numerous almost confluent puncta. Length 0.78 mm. . . . . *C. mons* (Chambers)
- *bb.* Shell not especially marked in any way. Dorsal seta of ramus three times the width of the ramus from the terminal claws — *C. obesa* Sharpe

5. Cypricercus Sars, 1895.

"Natatory setæ of both pairs of antennæ well developed; palp and masticatory lobe of the first maxillæ narrow. Caudal rami excessively developed and elongate, affording a ready means of recognition. Cœcal

appendage of the intestine unusually short; ovarian tubes much elongated." [Sharpe.] No American species known.

6. Cypridopsis Brady, 1867.

The first antenna is seven-jointed, the second five-jointed. The five natatory setæ of the second antenna are long and plumose. The branchia of the second maxilla consists either of a plate bearing five plumose setæ or else of two setæ inserted directly on the blade. Second foot five-jointed, bearing at its extremity a strong chitinous claw. Caudal rami rudimentary, flagellum-like. Parthenogenetic.

a. Branchia of second maxilla with five setæ. Shell marked with three more or less transverse, dark bands, which are confined to the dorsal and lateral surfaces. Very plump. Common. Length 0.54 mm. to 0.70 mm. . . . . *C. cypridopsis* (O. F. Mueller)

aa. Branchia of the second maxilla formed of two setæ.

b. Caudal ramus cylindrical and turgid, suddenly narrowing to a bristle . . . . *C. newtoni* Brady and Robertson

bb. Caudal ramus broad, gradually narrowing to a bristle.

c. Natatory setæ of the second antennæ reaching to the tip of the terminal claws. Shell pale green *C. villosa* (Jurine)

cc. Natatory setæ of the second antennæ reaching beyond the end of the terminal claws. Shell grass green on dorsal aspect . . . . *C. smaragdina* Vávra

7. Cyprinotus Brady, 1885.

Shell rather thin, compressed, oval or subtriangular, height exceeding half the length, dorsal margin strongly arched, ventral aspect straight. Valves usually unequal, the left overlapping the right. The free edges of the left valve smooth, cephalic and caudal edges usually bordered with a hyaline flange. The free cephalic edge of the right valve usually armed with tuberculiform teeth. Natatory setæ of the second antennæ reach beyond the tips of the terminal claws. Caudal rami slender with smooth or very finely pectinated claws. Propagation sexual. Copulatory organs small, with an outer linguiform obtuse plate. The cylindrical core of Zenker's organ bears numerous wreaths of spines.

a. Length more than three mm.; color bluish white, with a group of scattered, large, sordid, yellowish punctures about the middle of each valve . . . . *C. grandis* Chambers

aa. Length between one and two mm.

b. Dorsal seta of caudal ramus more than half the length of the subterminal claw.

c. Dorsal seta the width of the ramus from the subterminal claw. Terminal claw of second foot nearly straight *C. pellucida* Sharpe

cc. Dorsal seta at least twice the width of the ramus from the subterminal claw. Terminal claw of the second foot strongly curved . . . . . . *C. incongruens* Ramdohr

bb. Dorsal seta of caudal ramus not more than half the length of the ramus.

c. Dorsal seta the width of the caudal ramus from the subterminal claw. Shell yellowish brown, marked with bluish black longitudinal stripes on the dorsum and sides, covered with coarse hairs, shell thin *C. burlingtonensis* Turner

cc. Dorsal seta of the caudal ramus twice the width of the ramus from the subterminal claw. Color yellowish green, shell reticulated with contorted lines which are most distinct on the cephalic portion of the valves. Shell thin *crena* Turner

8. Cypris O. F. Mueller, 1785.

Second antennæ five-jointed, natatory setæ extending to the tip of the terminal claws. Mandibular palp not extending beyond the tip of the mandibular teeth, the first mandibular process armed with two biarticulate thorns. Branchial plate of the first maxilla large, bearing stiff, plumose setæ. Second maxilla provided with a branchial plate. Caudal rami stout. Parthenogenetic.

a. Length three mm. or more.

b. Both spines on the first mandibular process of the first maxilla smooth, dorsal margin of shell strongly convex. Marked with dark bands . . . . *C. herricki* Turner

bb. Both spines on the first mandibular process of the first maxilla toothed, dorsal margin of shell nearly straight marked with dark bands . . . . *C. perelegans* Herrick

aa. Length between one and two mm.

b. Both spines on the first mandibular process of the first maxilla smooth.

c. Terminal claw of the second foot as long as the last joint. Shell noticeably less than three times as long as high.

d. Caudal ramus straight; subterminal claw two thirds as long as the terminal. Shell four ninths as high as long . . . . *C. clavata* Baird*

dd. Caudal ramus weakly S-shaped.

e. Subterminal claw of the caudal ramus half as long as the terminal. Shell two thirds as high as long . . . . *C. virens* Jurine

ee. Subterminal claw of the caudal ramus nearly as long as the terminal. Shell half as high as long *C. altissimus* Chambers

cc. Terminal claw of the second foot twice as long as the terminal segment. Shell fully three times as long as high. Subterminal claw of the caudal ramus half as long as the terminal . . . . *C. fasciata* O. F. Mueller*

bb. Both spines on the first mandibular process of the first maxilla toothed.

c. Shell not reticulated with broken lines.

d. Shell less than twice as long as high, terminal claw of the caudal ramus half as long as the ramus.

e. Subterminal claw of caudal ramus three fourths as long as the terminal . *C. testudinaria* Sharpe

ee. Subterminal claw two thirds as long as the terminal *C. fuscata* (Jurine)

dd. Shell more than twice as long as high. Terminal claw of the caudal ramus one third as long as the ramus. Subterminal claw two thirds as long as the terminal *C. fischeri* Lilljeborg*

cc. Shell reticulated. Terminal claw of the caudal ramus nearly three fifths as long as the ramus, terminal seta not more than one fourth as long as the terminal claw *C. reticulata* Zaddach

aaa. Length between two mm. and three mm., third and fourth joints of the first foot fused . . . . *C. pubera* O. F. Mueller*

9. Erpetocypris Brady and Norman, 1889.

General characters of the animal closely approaching those of Cypris; but the natatory setæ of the second antennæ do not reach nearly to the tips of the terminal claws, and they are not plumose. Second maxilla bears a branchial plate. Cannot swim, creeps along the bottom. Most forms parthenogenetic, some sexual.

a. Length about four mm. Claw on the last joint of the second foot seven-eighths as long as the last segment. Dorsal seta of the caudal ramus serrate and claw-like, close to the subterminal claw; dorsal edge of ramus finely toothed; ramus twenty times as long as wide; terminal seta about one third as long as the subterminal claw. Shell twice as long as high, the upper margin nearly straight *E. barbata* (Forbes)

aa. Length between two and three mm.

b. Claw on last joint of the second foot as long as that joint, shell about twice as long as high. Caudal ramus about ten times as long as wide, dorsal margin finely toothed *E. strigata* (O. F. Mueller)*

bb. Claw of last joint of the second foot three times as long as the last segment. Dorsal edge of caudal ramus armed with five combs of teeth . . . . *E. reptans* (Baird)*

aaa. Length between one mm. and two mm.

b. Dorsal setæ of caudal ramus transformed into a short spine or claw, situated near the subterminal claw. Shell seven thirteenths as high as long . *E. olivacea* (Brady and Norman)

bb. Caudal ramus with only the terminal claws developed, lacking both the terminal and dorsal setæ. Shell two and a half to three times as long as high . *E. minnesotensis* (Herrick)

10. Ilyocypris Brady and Norman, 1889.

Shell oblong, with a transverse median depression, coarsely punctate and tuberculate. Second antennal setæ non-plumose, few; reaching a little beyond the apex of the terminal claws. Mandible palp four-jointed, with a setose branchial appendage. First pair of maxillæ composed of four segments, and a large branchial appendage bearing numerous terminal and about five reflexed basal setæ. Second pair of maxillæ consisting of a conical lobe, which bears numerous short marginal setæ, at the apex four stout plumose setæ, and at the base an appendage of four radiating plumose filaments and a biarticulate process bearing three apical setæ, one of which is plumose. The penultimate joint of the second foot has two marginal setæ; the last joint three long apical setæ, but no claw. Caudal rami ending in two long and equal claws and one very short seta, marginal seta long, and attached near the middle of the ramus. No American forms known.

11. Notodromas Lilljeborg, 1853.

Shell of male and female unlike. Second antennæ of both male and female six-jointed, natatory setæ extending beyond the tips of the terminal claws. No branchial plate on the second maxilla; palp of same two-jointed in the female; in the male the terminal segment forms a scythe-shaped appendage. Second foot five-jointed, abdominal ramus long and slender. Eyes two, separate. Males numerous.

a. Shell subquadrangular, surface smooth and shining. In the female, the caudo-ventral angle of the shell terminates in a horizontal, backwardly projecting, squamous, spine-like plate
N. monacha (O. F. Mueller)

12. Potamocypris Brady, 1870.

Second antennæ four-jointed; natatory setæ numerous but short, not reaching beyond the middle of the terminal claws; last joint with two

strong terminal claws and two or three short, slender setæ. Mandible stout, palp three-jointed, with a single branchial seta near the base. Feet as in Cypris, caudal rami rudimentary, consisting of a long seta, with a lamellar base bearing a short seta which is usually situated near the base of the lamellar portion. Shell compressed. No American forms known.

13. Scottia Brady and Norman, 1889.

Shell not unlike that of the tumid forms of Cypris. Natatory setæ of the second antennæ extremely short, not reaching the base of the terminal claws. Limbs short and stout ; claws of the caudal rami very stout, short, and twisted. No American forms known.

14. Stenocypris Sars, 1889.

Natatory setæ of the second antennæ not reaching beyond the tips of the terminal claws. Palp of the first maxilla very narrow, cylindrical, the last joint small, the masticatory lobes long and narrow. Caudal rami large, rather lamelliform, dorsal edges occasionally pectinate ; claws very unequal, both coarsely denticulate ; setæ of dorsal edge absent or small, apical seta long. Parthenogenetic. Shell narrow, height much less than half the length. No American forms known.

15. Typhlocypris Vejdovsky, 1882.

Second antennæ five-jointed in the female, six in the male. Natatory setæ of the second antennæ lacking. No eyes. Branchial plate of the second maxilla composed of two unequal plumose seta. No American forms known.

II. Cytheridæ.

Limnicythere Brady, 1868.

Shell strong, irregularly tuberculate or spinous. First antennæ five-jointed, with short bristles on their outer edge. Branchial plate of the mandibles strongly developed. Caudal rami rudimentary, usually only two short bristles. Males rare.

a. Terminal segment of first antenna seven times as long as wide. Second antennæ not especially armed in male. Rudimentary caudal rami cylindrical, about three times as long as wide *L. reticulata* Sharpe

aa. Terminal segment of the first antenna four to five times as long as wide. Second antenna of the male has its terminal claw armed with three or four strong teeth. Rudimentary caudal rami six to seven times as long as broad . . . . *L. illinoisensis* Sharpe

III. Darwinulidæ.

Darwinula Brady and Robertson, 1870.

Shell smooth, thin, and fragile. First antennæ short, stout, five- or six-jointed, strongly armed with stout, short setæ. Second antennæ stout, composed of four or five joints, no natatory setæ, no poison gland or urticating setæ. Mandible palp three-jointed, the basal joint large and densely setiferous. First maxilla bears a large branchial plate; the second a small branchial plate and a pediform palp. Post-abdominal rami subconical, small.

a. First antennæ composed of six joints, the second antennæ of four. Antepenultimate joint of the second antenna does not bear a conspicuous one-jointed appendage. Length 0.8 mm.
D. stevensoni Brady and Robertson *

aa. First antennæ composed of five joints, the second of five. Antepenultimate joint of the second antenna bears a conspicuous one-jointed appendage, which terminates in one long and one short filament. Length 0.68 mm. to 0.70 mm.
D. improvisa Turner

REVIEWS OF RECENT LITERATURE.

GENERAL BIOLOGY.

Natural Science and Philosophy. — Borntraeger Brothers[1] announce the programme of a series of chapters in popular knowledge by Dr. Adolf Wagner. The series is entitled *Studies and Sketches in Natural Science and Philosophy*, of which Nos. I and II have already appeared. The first of the series, Concerning Scientific Thinking and Popular Science, stands as a methodological introduction to the whole group by its discussion of the attitude of the logical thinker and of the process and results of epistemological analysis. After a discrimination of empirical investigation from critical reflection, in which the ease of the former and the difficulties which lie in the way of the latter are pointed out, the author goes on to indicate the nature of scientific thinking in general.

It is not any body of truth, or any form of expression, or any method of inquiry, — in so far as method means the employment of specific scientific instruments, — it is not the investigation of any particular problem or group of problems. Scientific thinking can be characterized only as an intellectual attitude, a method applicable to all possible subjects of investigation. It is, in short, sincere, critical thought, which admits belief only as it is based on evidence. Theoretical science, says the author, has attained no higher example than the canons of logical thought. It is criticism as opposed to dogma. Dogmatism remains dogmatism even when it speaks the phrases of science, and science, if it is sincerely to fulfil its office, must be kept free from the very taint of dogma.

This critical attitude of the thinker once made clear, an epistemological analysis of the nature of experience is entered upon in a series of discussions concerning things and properties, succession and connection in experience, cause and effect, laws and processes, reality and phenomena. The reader is then prepared to take up in detail the criticism of experience, of which the first aspect treated is the freedom of the will (No. II).

[1] Wagner, Dr. Ad. *Studien und Skizzen aus Naturwissenschaft und Philosophie.* I. Ueber wissenschaftliches Denken und populäre Wissenschaft. II. Zum Problem der Willensfreiheit. Borntraeger Bros., Berlin.

The style is easy, direct, and colloquial, and expresses a consistent endeavor after the utmost simplicity of statement and freedom from all technical terminology. One might call these booklets "guides to scientific thinking," in short words with easy illustrations, for their burden is told as to a child and the reader is *du-und-diched* throughout. Withal, however, the arrangement is clear and the exposition good, and the striving after simplicity is induced by a sense of the great impediments which the untrained thinker must meet in dealing with all profound critical problems. For the object of these studies is not to make known new facts to the reader but to stimulate him to logical reflection, not to furnish the memory but to arouse independent thinking. The world is fond of a phrase, for thinking is burdensome, and there are many technical terms on the lips of the reading public which have filtered through the magazines and popular books from scientific writings and are facilely employed but ill-understood. Evolution, mechanism and teleology, heredity and Darwinism, egoism, freedom of the will, — these phrases clothe the most significant problems of science and philosophy. The moment a new thought, a successfully daring speculation is represented in a phrase the imitative herd seizes upon it and bandies it glibly about, with commonly the most inadequate grasp of its meaning. To arouse a candid reflection upon such terms, to make the reader honestly attempt an analysis and comprehension of them for himself is the aim of these little books.

The following chapters of the series are already announced: Evolution in Nature; Heredity and Darwinism; On the Freedom of the Will; The Philosophy of Egoism; Mechanism and Organism; Instinct; On *a priori* Knowledge; The Division of Labor; On Positivism in Natural Science; The Mechanics of Evolution; Morals and Intellect.

ROBERT MACDOUGALL.

ZOÖLOGY.

Emery's Zoologia. — The last fifteen years have been characterized by the appearance of an unusual number of good zoölogical text-books. Most of these works have first appeared in German, French, or English; Emery's[1] *Compendium of Zoölogy* is in Italian. The field covered

[1] Emery, C. *Compendio di Zoologia.* vii + 456 pp., 600 illustrations and a map. Bologna, Nicola Zanichelli, 1899.

by these books has been so thoroughly worked over that any new effort in this direction could hardly be expected to possess great novelty and would naturally differ from its predecessors only in details. Emery's book is conventionally divided into a general part, of some hundred pages, devoted to the principles of zoölogy, and a special part, of over three times this length, containing a descriptive classification of the animal kingdom.

In the special part the Protozoa and Metazoa are recognized as primary divisions. The term radiates (zoöphytes) is resurrected to include the sponges, cœlenterates, and ctenophors; all the remaining Metazoa are placed in the group Bilateralia. This includes the worms (under which are placed the Platyhelminthes, worms proper, molluscoids, and Enteroptneusta), the echinoderms, the mollusks, the arthropods, and the chordates. The innovations in classification so far as they affect the larger divisions are brought about chiefly by the fusion of what were formerly considered separate groups. This seems to us to make for unnaturalness in the classification; thus it is very improbable, as in fact the author admits, that the group of worms as constituted above is a homogeneous assemblage, and the division Bilateralia is in a similar way still less justifiable.

The general part, which, so far as it goes, is well written, naturally offers a much greater opportunity for individualizing the book. It is prefaced by a short historical account in which the foreigner is struck by the translations of familiar names, such as Giovanni Mueller and Carlo Darwin. Then follows a brief but well-written chapter on protoplasm, its activities, the cell, direct and indirect division, etc. A brief treatment of histogenesis and organogenesis is followed by an account of the architecture of the metazoan body and a discussion of radial and bilateral symmetry, of metamerism, and of the laws of homologies. The significance of the individual and the formation of colonies are then dealt with. Reproduction is the title of the next chapter. Protozoan and metazoan reproduction are comprehensively compared, and such topics as sexual reproduction, parthenogenesis, alternation of generations, and heredity are considered. The evidences and consequences of evolution conclude the general part. This is perhaps the best chapter in the book, and the happy selection of Italian examples and illustrations makes it enjoyable reading even to the mature zoölogist.

While the general part compares very favorably with the corresponding portion of other works, it has two obvious deficiencies —

the almost total lack of any comparative physiological and histological statements. The absence of the former may be in part justified by the disorganized condition that the science of comparative physiology is still in, but no such excuse can be urged for comparative histology, which has already received good treatment in several text-books.

To a foreigner the text seems generally free from typographical errors, though occasional misprints, as Crincidi for Crinoidi (p. 217), are to be noticed. The text justifies a much better letter-press, and it is to be regretted that so many of the figures are spoiled by poor printing. In the map illustrating the zoögeographic regions (p. 72) the areas designated by different kinds of shading are scarcely to be recognized, and while many well-known islands have apparently sunk below the surface, numerous small archipelagoes of printer's ink have made their appearance in unexpected quarters. On the whole, the book deserves hearty commendation and ought to exert a stimulating influence on the study of zoölogy in Italy.

G. H. P.

Jordan's Manual of Vertebrates. — An eighth edition of this work is just issued from the press of A. C. McClurg & Co., Chicago. In it the nomenclature is brought to date, that of the fishes in an appendix, that of reptiles and birds by changes in the plates, and that of the mammals by a rewriting of the text. In the latter group special assistance has been given by Mr. T. S. Palmer of Washington, and in the reptiles by Dr. Leonhard Stejneger and others.

The volume now contains condensed descriptions of 1149 species of vertebrate animals native to the northeastern United States and arranged in 610 genera. Since the first edition in 1876 great changes have taken place in the nomenclature of these animals, not half the species retaining the scientific name then recognized.

All these changes have been, however, in the direction of stability of nomenclature, and the specific names in twenty-nine cases out of thirty are now permanently fixed by the law of priority.

Generic names must always vary with different views of convenience in the valuation of groups. Unfortunately they still fluctuate through variations in the methods employed in the restriction of the collective groups of the older authors.

The book is well printed, and the binding has improved with each consecutive edition.

Envelopes of the Spinal Cord. — Sterzi has studied this subject from a comparative standpoint (*Anat. Anz.*, Bd. XVI, p. 230) and points out that in the fishes there is but a single envelope proper, the meninx primitiva. In the Amphibia two meninges are developed, a meninx secundaria and a dura mater, separated by a series of lymph spaces. In the mammals these are represented by the three well-known membranes. In development the various meninges are developed from a single meninx primitiva by the formation of lymph spaces. Above the dura is an epidural space, whose lateral walls are formed by the so-called "Kalkorgan," a membrane with numerous cavities, containing crystals of calcic carbonate, but which is not to be considered as one of the true envelopes of the cord. The endorhachis is a strong fibrous membrane which serves as the periosteum of the spinal canal.

Origin of Mammals. — In the discussion on the origin of the mammals[1] recently held at the fourth international congress of zoölogy, Professor Seeley stated as his opinion that the anomodonts were not ancestors of the mammals, but that both groups had a common ancestor to be sought for in rocks earlier than the Permian. The forms thus far discovered, however, show so close a connection between reptiles and mammals that it is not reasonable to believe that future discoveries will seriously alter this assumed connection. Professor Osborn believed that much of the resemblance between reptiles and mammals was due to parallelism and pointed out that the mammal egg was more amphibian than reptilian in character. If the ancestor of the mammal was a reptile it was one that retained certain amphibian characters. Professor Marsh expressed the opinion that none of the fossil reptiles thus far known could be said to be a satisfactory ancestral representative of the mammals and suggested the origin of this group from primitive amphibians. Professor Haeckel argued for the monophyletic origin of placental mammals from one marsupial ancestor. Mr. Sedgwick thought the question of the origin of mammals was possibly insoluble from the facts that embryological evidence is not sufficiently conclusive and that the paleontological remains are too fragmentary. Professor Hubrecht defended the view that mammals may have had a polyphyletic origin and raised the question whether mammals other than monotremes had descended from oviparous ancestors.

G. H. P.

[1] The Origin of Mammals, *Proc. Fourth Internat. Congress Zoöl.*, pp. 68–75. 1899.

Placenta of Tarsius and of Tupaja. — Professor A. A. W. Hubrecht[1] has made a careful study of the placentas of Tarsius and of Tupaja to determine whether these organs are centers for the formation of blood corpuscles (hæmatopoetic organs). He concludes that blood corpuscles are produced on both the maternal and embryonic sides of the placenta and that many of the corpuscles which are produced from embryonic tissue make their way into the maternal circulation. The bearing of this on questions of telegony is obvious, though it must not be forgotten that in some mammals this kind of blood formation does not occur. G. H. P.

Uterus masculinus of the Rabbit. — Professor Ramsay Wright[2] confirms Kölliker's statement that the so-called *uterus masculinus* in the rabbit is formed from the fused caudal ends of the Wolffian ducts and not from the Müllerian ducts as might be inferred from its name. The organ then is not homologous with the vagina of the female nor with the *uterus masculinus* in man. G. H. P.

Fossil Hyracoid. — Professor H. F. Osborn[3] has described a new species of fossil Hyrax, *Pliohyrax kruppii*, from the Lower Pliocene of Samos. The specimen is interesting in being the only well-established fossil remains of this peculiar group. G. H. P.

Bipedal Lacertilia. — Mr. W. Saville-Kent[4] has collected evidence on bipedal locomotion among existing lizards and finds that it may be assumed by the following species: *Chlamydosaurus kingi*, *Physignathus leseuri*, *Amphibolurus muricatus*, *Agama stellio*, *Teguexin americanus*, *Ameiva surinamensis* (according to Mr. H. Prestoe), and *Basiliscus americanus* (W. F. H. Rosenberg). Presumably this habit has been inherited from some such ancestor as the extinct bipedal Dinosauria. G. H. P.

[1] Hubrecht, A. A. W. Ueber die Entwickelung der Placenta von Tarsius und Tupaja, *Proc. Fourth Internat. Congress Zoöl.*, pp. 345–411, 12 pls. 1899.

[2] Wright, R. On the So-called *Uterus masculinus* of the Rabbit, *Proc. Fourth Internat. Congress Zoöl.*, p. 185. 1899.

[3] Osborn, H. F. On *Pliohyrax kruppii* Osborn, a Fossil hyracoid, from Samos, Lower Pliocene, in the Stuttgart Collection, *Proc. Fourth Internat. Congress Zoöl.*, pp. 172, 173, 1 pl. 1899.

[4] Saville-Kent, W. Bipedal Locomotion among Existing Lizards, *Proc. Fourth Internat. Congress Zoöl.*, pp. 168, 169. 1899.

Lateral Fins of Fishes. — Professor W. Salensky[1] has given a brief but important report on the development of the lateral fins of fishes. According to Gegenbaur, the lateral fins of fishes are derived from modified gill arches, and the fish in which the most primitive form of fin occurs is Ceratodus. Professor Salensky has studied the development of the lateral fins in the sterlet and in Ceratodus. In the pectoral fin of the sterlet the fifth to the tenth myotome produce muscle buds which give rise to the musculature of the fin. Myotomes posterior to these also give rise to buds which, however, abort. The fin rays do not produce basalia by the fusion of their proximal ends, but rays and basalia come from a common blastema. In Ceratodus the sixth to the tenth myotome contribute muscle buds to the fin. The skeleton of the fin appears in the form of a single rod of cartilage and the rays bud out from it without reference to the muscle buds. The rays are comparable with the secondary rays, not with the ordinary rays of the fish fin. The cartilage axis of the fin is homologous with one of the basalia. As the muscles of the Ceratodus fin arise as in other fishes, it is fair to assume that the Ceratodus fin is not a primitive fin, as Gegenbaur believed, but is a greatly reduced fin of the ordinary type. These facts in large measure destroy the slight support that Gegenbaur's archipterygium theory formerly had.

G. H. P.

The Chiasma of the Optic Nerves of the Amphibia has been studied by Franz Fritz (*Jen. Zeit.*, Bd. XXXIII, p. 191), both by microscopic and by degeneration methods. His most important result is that there is a total crossing of the optic nerves. Professor Kölliker has lately confirmed several of the results of Ramon y Cajal as to the existence of numerous unilateral and direct fibres in the chiasma of certain mammals (*Verhandl. Anat. Ges.*, Bd. XIII, 1899), and the fact that in some cases fibres divide in the opticus, and the two branches go to the two tracts.

Eigenmann on the Blind Fish of the Caves. — One of the most valuable contributions yet made to the literature of Organic Degeneration is a paper entitled "The Eyes of the Amblyopsidæ," being the first of a series on "The Eyes of the Blind Vertebrates of North America," by Dr. Carl H. Eigenmann. It is published in Roux's

[1] Salensky, W. Zur Entwicklungsgeschichte des Ichthyopterygiums, *Proc. Fourth Internat. Congress Zoöl.*, pp. 177–183. 1899.

Archiv für Entwickelungsmechanik der Organismen, seventy-two pages, with six plates, part of them colored, and ten figures in the text.

In this memoir Dr. Eigenmann describes the degraded condition of the eyes in the six known species of the Amblyopsidæ, three of them (*Chologaster cornutus*, *C. papilliferus*, and *C. agassizii*) with small but developed eyes, and three, *Amblyopsis spelæus*, *Typhlichthys subterraneus*, and *Troglichthys rosæ*, being blind. The blind species are not very close to one another, and each must have been independently derived from eyed forms. Typhlichthys is descended from Chologaster, the others from genera now extinct.

After an exhaustive study of the anatomical details, Dr. Eigenmann takes up the causes of the degeneration of the parts of the eye, and their replacement in the orbit by masses of fat. He considers in detail the theory that the organ diminishes with disuse (ontogenic degeneration) and that the effect of disuse appears to some extent in the next generations (phylogenic degeneration).

A second theory is that of panmixia, the cessation of selection in which the general average falls progressively the birth average as maintained in selection.

A third is a reversed action of natural selection, by which the organ degenerates through the migration of those with good eyes to the light, or through their extermination on account of the waste in weight or nutrition, or through injury to the useless eye.

Still another view is that of the struggle of the parts either for room or for food. By this the unused eye may be crowded out or starved.

Another view refers the degeneration of the organ to a struggle between soma and germ to produce the maximum efficiency of the former with the minimum expenditure of the latter.

Or again we may suppose that the result follows, through germinal selection, the struggle of the representatives in the germ.

Dr. Eigenmann calls attention to the fact that while we ought to consider, first, the causes of individual generation and, second, the processes or causes which led to its transmission, practically it is impossible to do so. Again the eye is itself a complex organ, and when each of its parts loses its utility, the degeneration progresses unequally. His final conclusion is, that "the condition of the eyes in the blind fishes can only be explained as the result of the transmission of *disuse* effect." The eye (functional) of Chologaster is symmetrically reduced from a larger normal fish eye. The retina is the

first structure simplified. Later the lens and especially the vitreous body degenerated more rapidly than the retina. The muscles in Typhlichthys have disappeared. The scleral cartilages have not failed to the same extent as the active structures of the eye. The degeneration is in no case due to arrested development. D. S. J.

Abbott on the Marine Fishes of Peru. — An excellent piece of faunal work is "The Marine Fishes of Peru," by James Francis Abbott, published in the *Proceedings of the Academy of Natural Sciences of Philadelphia* for June, 1899.

The paper is based on the collections made by Rear-Admiral L. A. Beardslee, U. S. N., at Callao, while in command of the *Philadelphia*. This accomplished officer has long taken a deep interest in natural history matters, and this collection presented by him to Stanford University is a proof of such interest.

Mr. Abbott notes 102 species as recorded thus far from Peru, and thirty of them are included in the Beardslee collection. Mr. Abbott describes as new the following species from Callao: *Basilichthys octavius*, *Basilichthys regillus*, *Basilichthys jordani*, *Pisciregia beardsleei*, and *Sciæna gilberti*. The new genus Pisciregia is allied to the California genus Atherinopsis, having a similar non-protractile premaxillary, but the vomer is armed with recurved teeth; the outer teeth in the jaws are enlarged, and the first dorsal is very small. The abundance of species of large-sized Atherinidæ (Pez del Rey), constituting the genera Chirostoma, Atherinopsis, Atherinops, Basilichthys, and Pisciregia, excellent food fishes all, is one of the notable features of the fish fauna of the eastern Pacific. D. S. J.

Fishes of French Guiana. — Dr. Léon Vaillant has published in the *Bulletin* of the Museum at Paris a paper on fishes collected in French Guiana, mostly from fresh waters.

Two new species are described: *Arius physacanthus*, from Rio Mahury; and *Rivulus geayi*, from Rio Cachipour. The Arius is allied to *emphysetus* and should be placed with it in Sciadeichthys if the modern genera of Bleeker are adopted. D. S. J.

Australian Tunicata. — Students of the Tunicata have known for some years that Professor W. A. Herdman has been occupied with the investigation of the collections of this group belonging to the Australian Museum at Sydney, New South Wales, and his report has

been looked forward to with interest. After a considerable delay, due to the late financial depression in Australia, the work has now been published as *Catalogue No. XVII* of the Museum. That it is of the highest order of scientific excellence hardly needs to be said, particularly for those who are familiar with Professor Herdman's distinguished work in the past on this group of animals.

The author has entitled his report a "Descriptive Catalogue of the Tunicata in the Australian Museum, Sydney, New South Wales," and he says that it is not to be regarded as a monograph on Australian Tunicata. He tells us that he was expressly enjoined by the trustees of the Museum "not to enter into anatomical and histological details beyond what he considered necessary for the elucidation of the systematic position and the sufficient description of the various species." The fact, consequently, that he has devoted nearly one hundred large octavo pages and forty-two plates to the description of the sixty-two new species serves as an index to what this veteran ascidiologist believes to be the briefest treatment consistent with exactness in this group.

In his introduction he gives a brief discussion of classification and concludes that, despite the various quite radically different systems that have since been proposed, he sees no sufficient reason for departing widely from the one adopted by him in his *Challenger* report of 1882. And he justly remarks that he feels himself strengthened in his position by the fact that this system has been quite generally adopted by recent writers, notably by Seeliger in his "Tunicata" for Bronn's *Klassen und Ordnungen des Thierreichs.*

He does, however, introduce one modification of considerable importance. He divides the Ascidiæ compositæ into two sections, one of which contains the "compact-bodied families," Botryllidæ and Polystyelidæ, and the other the "remaining families with extended or divided bodies." For these he proposes to adopt the names "Holosomata" and "Merosomata," respectively, if Sluiter, who first used them, but in a somewhat different sense from that in which Herdman proposes to use them, will agree to Herdman's modification. Or if Sluiter refuses to accept this modification, then Herdman will adopt the terms "Pectosomata" and "Chalarosomata" for the respective groups.

There can be no doubt, particularly since the Polystyelidæ and Botryllidæ have been shown to agree so closely in their method of budding, that they should be associated more closely in classification than either family can be with the other families of compound ascid-

ians. I believe, however, that the point of similarity emphasized by Professor Herdman's proposal, *viz.*, the compactness of the body, is considerably less fundamental than some other characters that might be selected, particularly that of the method of budding. Furthermore, the term "Holosomata" does not apply to these two families any more than it does to Perophora, which genus the author does not, of course, associate with the Botryllidæ and Polystyelidæ.

I would not go so far as Garstang has in relying upon the character of the budding as a basis for classifying the compound ascidians, but I believe that in the present state of our knowledge the most natural grouping of them that can be made is into two sections. One of these would include those in which the buds arise directly from the body of the parent, and the other those in which the budding is from a stolon. The first section might well be called the "Somatoblastica" and the second the "Rhizoblastica." These sections would correspond to Herdman's, with the exception that it would remain for the present an open question as to which one should contain the Didemnidæ, the probabilities being, however, that this family would ultimately find its place among the Somatoblastica.

Those who object to mongrel words will be likely to find fault with "Pectosomata" on etymological grounds.

At the close of the report the author has given a list of all the species of Tunicata thus far known from Australian waters. This list includes 187 species, distributed as follows among the three divisions of the group:

Larvacea	1 species
Thaliacea	7 species
Ascidiacea	179 species

The work is a very important contribution to the general zoölogical knowledge of this group. Less can be said in favor of the volume from the bookmaker's than from the naturalist's point of view, but it will serve its purpose well, and that is the essential thing.

WM. E. RITTER.

The Coccidæ of Mauritius. — M. d'Emmerez de Charmoy has recently published a very interesting account of the Coccidæ of Mauritius, in a pamphlet issued by the Société Amicale Scientifique of that island. As it is probable that this work will not fall into many hands, it may be worth while to give a list of the species,

correcting the nomenclature at the same time, so far as seems necessary : —

Aspidiotus aloes simplex, n. var., p. 20.
A. articulatus simplex, n. var., p. 21.
A. tesseratus, n. sp., p. 23.
A. maskelli, Ckll., p. 24.
A. cyanophylli, Sign., p. 24.
A. lataniæ, Sign.
  = *A. cydoniæ*, p. 25.
A. trilobitiformis, Green, p. 26.
Chrysomphalus aonidum, L.
  = *A. ficus*, p. 25.
C. cladii, Mask.
  = *A. cladii*, p. 22.
C. aurantii, Mask.
  = *A. aurantii*, p. 22.
Parlatoria sp. ?
  = *P. zizyphi*, p. 27.
Diaspis euphoriæ, n. sp., p. 28.
D. pentagona, Targ.
  = *D. amygdali*, p. 29.
D. calyptroides cacti, Comst., p. 29.
Howardia biclavis, Comst.
  = *Chionaspis biclavis*, p. 30.
Chionaspis dilatata, Green, p. 31.
C. sp. ?
  = *C. quercus*, p. 30.
C. tegalensis, Zehnt., p. 31.
Mytilapsis hibisci, n. sp., p. 32.
M. greeni, n. sp., p. 33.
M. beckii, Newm.
  = *M. citricola*, p. 34.
M. gloveri, Pack., p. 35.
Fiorinia fioriniæ, Targ.
  = *F. camelliæ*, p. 37.
F. cockerelli, n. sp., p. 37.
F. alæodendri, n. sp., p. 36.
Aonidia (?) *allaudi*, n. sp.
  = *F. allaudi*, p. 35.
A. (?) *allaudi galliformens*, n. var.
  = *F. a. galliformens*, p. 36.
Vinsonia stellifera, Westw., p. 38.
Ceroplastes vinsoni, Sign., p. 38.
Lecanium oleæ, Bern., p. 39.
L. hemisphæricum, Targ., p. 40.
L. hemisphæricum filicum, Boisd., p. 40.
L. longulum, Dougl., p. 40.
L. nigrum, Nietn., p. 40.
L. tessellatum, Sign., p. 40.
L. viride, Green, p. 41.
Pulvinaria cariei, n. sp., p. 41.
Asterolecanium bambusæ, Boisd., p. 42.
A. miliaris, Boisd., p. 42.
A. pustulans, Ckll. ?
  = *A. quercicola* ?, p. 42.
Oudablis sp. ?
  = *Phenacoccus nivalis*, p. 42.
Dactylopius calceolariæ minor, Mask., p. 44.
D. virgatus, Ckll., p. 44.
D. filamentosus, Ckll.
  = *D. vastator*, p. 45 (fide Tinsley).
D. sacchari, Ckll., p. 45.
D. citri, Risso, p. 45.
D. longispinus, Targ.
  = *D. adonidum*, p. 46.
  = *D. pteridis*, p. 46.
Orthezia insignis, Dougl., p. 46.
Icerya seychellarum, Westw., p. 47.
Chætococcus bambusæ, Mask.
  = *Sphærococcus bambusæ*, p. 48.

Thanks to M. de Charmoy, the writer has been able to examine some of the new species. The *Mytilaspis hibisci*, unfortunately not figured, is close to *M. crawii*, but easily distinguished by the dark scale. The *Aonidia* (?) *allaudi* is a beautiful and singular thing, and could be considered the type of a new genus. *Aspidiotus tesseratus* is not a Diaspidiotus, as M. de Charmoy has it, but a Pseudaonidia. Singularly enough, it was found almost simultaneously, by Professor C. H. T. Townsend, at Coatzocoalcos in Mexico, and described by the present writer under a different name, which latter,

now in press, will be withdrawn. The identity of *Dactylopius vastator* with *D. filamentosus* was lately discovered by Professor J. D. Tinsley, who is about to publish an article on the subject. *Euphoria longana*, the plant on which *Diaspis euphoriæ* was found, is properly a Nephelium.

T. D. A. Cockerell.

The Corpora allata of the Orthoptera. — Heymons describes (*Sitzber. Preuss. Akad. Wiss.*, 1899, Nr. 30) two small bodies, the corpora allata, lying immediately above the œsophagus in the head of *Bacillus rossii.* At first sight they appear as if they were a second pair of pharyngeal ganglia of the sympathetic system, as they lie immediately above the paired visceral nerves. Sections, however, show that, while they lie on these nerves, they are non-nervous in structure. They are vesicular in nature, composed of a single layer of columnar epithelium, the cavity of the vesicle being filled by a stratified chitine, apparently molted by the epithelium. In development these corpora arise as ectodermal ingrowths from the ventral surface, on the boundary between the mandibular and maxillary segments. From these ingrowths a pair of small cell masses, at first solid, bud off and gradually pass dorsally to the definitive position. Concerning the function of these structures, which have been seen in Hymenoptera and other forms by other students, Heymons has little definite to offer. Experiments by extirpation of the structures from living insects showed that they apparently are not organs of equilibration, while the absence of sensory hairs would seem to suggest that they are not sensory in structure. The absence of ducts and of concrements and excretory granules in the protoplasm would militate against a glandular nature. The suggestion is made that they were originally peripheral organs and that, with their migration to an internal position, they have lost their primitive significance.

Systematic Position of the Fleas. — Dr. Heymons, in a short paper (*Zool. Anz.*, Bd. XXII, p. 223), gives his opinions upon this mooted question. He claims that Kräpelin's views of the homologies of the mouth parts are erroneous, there existing in all stages a labrum, and a pair each of mandibles and maxillæ, the latter with palpi and a labium. The wounds produced by these animals are not caused by the upper lip, but by the mandibles which are worked by two protractors and two retractors. Anatomical structure goes to show that these forms are to be regarded as forming a distinct order (Siphonaptera), and that Puliciphora, often considered as an annectent form

on the dipteran side, is a true fly of the family Phoridæ, without any siphonapteran affinities.

The Sting of the Hymenoptera. — Zander has studied the structure of the sting in sixty-two hymenopterous insects and, among other conclusions (*Zeit. wiss. Zool.*, Bd. LXVI, p. 289), comes to the support of the views of Heider, Heymons, and Kulagin, that the elements of the sting (*i.e.*, the gonapophyses) are not homologous with the other appendages. This conclusion is based on the fact not only that these structures arise much later than the abdominal legs, but that they arise in a position nearer the middle line than do the transient abdominal limbs.

Nematodes. — Dr. O. von Linstow[1] has just published the results of his studies on the parasitic nematodes of the Berlin Zoölogical Collection. The paper is altogether the most extensive contribution to this much neglected and little known group that has appeared in recent years. It includes descriptions of forty-nine species, of which thirty-eight are new to science. Among them the genus Ascaris was represented by twelve species, and Filaria by nine, while the other species were distributed through numerous genera, two of which, however, were entirely new. These forms were collected from every continent except North America and were taken from hosts in every group of vertebrates.

Among items of general interest was noted the abundant occurrence in fish of ascarid larvæ, often of considerable size, whereas *Ascaris lumbricoides*, the human round worm, of which the life history is known, undergoes direct development, *i.e.*, has no intermediate host.

A striking form is the new genus Pterocephalus from the intestine of the zebra in east Africa. The head of the adult parasite bears six conical spines, six hooks, and six deeply serrated leaf-like appendages which are attached only at their constricted bases. While the hooks and spines are directed anteriad, these appendages lie prone and reversed; when, however, the mouth opening is drawn in and the spines and hooks inverted and concealed, the appendages are turned anteriad and project from the anterior margin of the head curiously like wings, hence the generic name. These structures are wanting or only faintly indicated in the immature forms.

Spiroptera (an *Filaria*) *bicolor*, previously reported by von Linstow

[1] Linstow, O. von. Nematoden aus der Berliner Zoologischen Sammlung, *Mitth. a. d. Zool. Samml. d. Mus. f. Naturk. Berlin*, Bd. i, Hft. 2 (1899), 28 pp., 6 pls.

from a German catfish, appeared again from a fresh-water fish of Australia. Another unexpected discovery was a new species of Syngamus, the gap worm of fowls. This new form occurred in the choana of a deer from Rio Grande do Sul, and in the nasal cavity of a goat from Cameroon. Only one other species of this genus occurs in the Mammalia : *Syngamus dispar* in the trachea of *Felis concolor.*

This paper constitutes the second number of a new series of publications from the Museum für Naturkunde, Berlin ; the management of the museum is certainly to be congratulated on the admirable form in which the series is being published.

Movements of Pseudopods. — M. Eugène Penard has recently published[1] an account, rather too brief, of his observations "sur les mouvements autonomes des pseudopodes."

The results of most interest may be summarized as follows (they relate chiefly to *Difflugia lebes* Penard): —

1. If a severed pseudopod be removed from the parent to a distance not more than two or three times the diameter of the shell of the parent, it will, after having remained in a globular, motionless condition for a short time, extend itself toward the parent, and finally reach it and become fused with it, the junction with the parent usually being at the latter's mouth.

2. If the original point of contact is not at the parent's mouth, the returning pseudopod moves along the shell of the parent until it reaches this point.

3. When the returning pseudopod comes very near the parent, the latter usually extends one of its own pseudopodia toward it, and this particular paternal process becomes larger than the others.

4. The absorption of the detached pseudopod by the parent is not an act of digestion and assimilation, as is proved by the fact that the fragment is not taken into a vacuole of the parent, nor into its interior in any way ; and by the further fact that the act of absorption is fully accomplished in a much shorter time than is required for a true digestion.

5. Severed pseudopodia are attracted neither by one another nor by foreign bodies of practically the same size as the parent.

6. If a different individual Difflugia, of the same or of another species, be placed near an amputated pseudopod, the latter not only will not be attracted toward the former but will actually move away from it.

W. E. R.

[1] *Archives des Sciences physiques et naturelles*, Mai, 1899, pp. 434–445.

Notes. — *Nectonema agile* has been reported by Pintner (*SB. math.-natw. Cl. K. Akad.*, Wien, 13. April, 1899) from the Bay of Naples. In March a single specimen was collected and in May two others. As it is hardly credible that such a conspicuous form could have been overlooked hitherto, this sudden appearance so remote from the south shore of New England, the only locality from which it has heretofore been recorded, is certainly remarkable.

The cestodes of the Bergen Museum have recently been studied by Lönnberg (*Bergens Museums Aarbog*, No. 4, 1898). An extended study was made of Cœnomorphus, the peculiar tetrarhynchid larva of P. J. van Beneden. According to the author it departs widely enough from the typical tetrarhynchids to be regarded the representative of a new subfamily. Its anatomy is well illustrated, as also that of some other cestodes.

Gordii from Malaysia and Mexico are discussed by Camerano (*Atti Acc. Sci. Torino*, Vol. XXXIV, 1899). The two Mexican forms are species of the genus Chordodes.

The South African species of Peripatus are enumerated by Purcell (*Ann. of South African Mus.*, 1899), who describes seven distinct and one doubtful species. He accepts Pocock's subdivision of the genus Peripatus and includes the South African species in Peripatopsis and a new genus, Opisthopatus.

Maurer has placed considerable weight upon the distribution of the hair in embryo mammals as evidence for the derivation of hair from epidermal sense organs (see this journal, Vol. XXXI, p. 767). De Meijere has studied the subject and concludes (*Anat. Anz.*, Bd. XVI, p. 249) that this distribution affords little support for Maurer's views. In this connection it is to be noted that Kromayer (*Archiv für Entwickelungsmechanik*, Bd. VIII) describes the hair as having a dermal Anlage.

Negri has followed the processes described by Petrone for demonstrating the nucleus in the red-blood corpuscles in the mammals. He finds (*Anat. Anz.*, Bd. XVI, p. 33) that Petrone's methods (osmic acid, 1 : 4000; picric acid, 1 : 4000; formic acid carmine) give a differentiated central portion in the corpuscle. The same methods applied to the blood of embryonic mammals bring out a similar structure, while at the same time hæmatoxylin differentiates a true nucleus. Hence he concludes that Petrone's structure is not a true nucleus,

a conclusion which agrees well with what was previously known concerning the development of the red corpuscles.

Gustav Fornier points out (*Biol. Centralblatt*, Bd. XIX, p. 549) that the lizard, *Lygodactylus picturatus*, and several other species of the genus are provided with a sucking disk at the end of the tail, similar in structure to those on the toes.

BOTANY.

Colors of Flowers. — The author of this contribution [1] to the discussion of the origin and significance of color in flowers has evidently set out with a clearly defined purpose. In his preface he declares that he was not entirely satisfied with the soundness of the theories of Grant Allen and of Hermann Müller, whom he brackets together as authorities. Moved by this discontent, he investigated the coloration of many flowers (and of some other things), and this little work embodies his results.

Briefly stated, Mr. Hervey's conclusions are to the effect that Grant Allen's hypothesis in regard to the sequence of colors, namely, that yellow is the primitive color, and that white, red or purple, violet or blue are more highly evolved colors, is an untenable one. Müller's statements in regard to the preferences of certain insects for especial colors are taken up in some detail and considerable evidence is adduced in the attempt to show that insects are somewhat indifferent to color, and that many of them, honey bees for example, find very inconspicuous and partially concealed nectariferous flowers by "instinct." Bumblebees, by some inscrutable neglect of evolution or Providence, have unfortunately been left out in the distribution of this instinct and have to get along without it, making up, however, to some extent for the lack of it by the brutality with which they bite through corolla tubes and help themselves to nectar.

The author offers "as an original solution of the subject [of the origin of honey-guides]" the statement: "This richness of color [in Tropæolum] is occasioned by the irritating influences of the bees in traversing the same route to and from the nectary, thus stimulating the flower to send more of its peculiar pigment to this point, same

[1] Hervey, E. Williams. *Observations on the Colors of Flowers.* New Bedford, 1899. 8vo, 104 pp.

as a little friction or a pinch will bring the blood to the cheek and cause a rosy tint." Even the lay reader will find little difficulty in judging of the value of the analogy between the development of pigment in cells of petals and the response of human arteries to stimulation transmitted from the central nervous system.

It is hardly worth while to multiply instances of inaccurate and fanciful reasoning like the case just cited. Evidently Mr. Hervey is not versed in modern systematic botany or he would not say, "The Ranunculaceæ are placed first in order in our floras, we imagine for the reason that the flowers of this family are very simple in construction." If he is acquainted with the histology of the sepals and petals which he is discussing as regards their coloration, the fact does not appear in his pages. In short, he is not sufficiently equipped successfully to attack the very difficult problem of the nature and genesis of the colors of floral organs. If his labors should prove to be of use to the scientific investigator, it will be by his having collected and tabulated a considerable number of facts in regard to the distribution of color in flowers and the sequence of tints where there are progressive changes of coloration.

JOSEPH Y. BERGEN.

The Teaching Botanist.[1] — To those who have kept in touch with the changing conditions of secondary education during the last decade, it has become most apparent that there has been a steadily growing demand that greater consideration should be given to the natural sciences. Very possibly the numerous summer schools maintained by the various colleges have served to cultivate and strengthen this tendency, if they were not directly responsible for it in the first instance; and the large number of teachers who annually take the time set apart for a much-needed rest to qualify themselves further in some special subject affords ample evidence, not only of the gathering force of the demand, but also of the seriousness of purpose which underlies it. In no subject has this movement gained greater headway than botany, and if evidence of this fact were needed, it might be found in the numerous text-books and laboratory guides which have appeared within recent years, all directed toward supplying working force to the teacher who is not a specialist, and who is usually compelled to divide his or her time among several subjects.

It has long been felt that some unification of method would be in

[1] *The Teaching Botanist*, a manual of information upon botanical instruction, together with outlines and directions for a comprehensive elementary course, by W. F. Ganong, Ph.D. New York, The Macmillan Company, 1899. 270 pp.

the highest degree desirable, though extremely difficult of realization. The very timely work by Dr. Ganong, however, promises to bring this ideal much nearer than heretofore. In *The Teaching Botanist* he has brought together in convenient form the best experience of our leading botanists as to the place which botany should occupy, and the best methods of presenting it with the greatest educational effect. It is in no sense a text-book, but it may be more appropriately called a "teacher's guide," occupying a field distinctly apart from the usual text-book.

After noting that botanical teaching is in a state of very rapid expansion and transition, and the unprecedented demand for a teaching that shall be more extensive, more thorough, and more representative of the present state of science, the author discusses The Place of Botany in Education, What Botany is of most Worth, and Things Essential to Botanical Teaching — chapters which are rich in suggestive thought and well merit the careful perusal of every conscientious and enterprising teacher. Botanical Books and their Uses adds much to the value of the work.

The second part is devoted to The Principles of the Science of Botany, in which is given an outline of a series of studies, illustrated by simple experiments which are well within the range of ordinary school work, and for which apparatus of a very simple and inexpensive kind will suffice.

The work marks a distinct advance in school methods and should be in the hands of every teacher.

D. P. P.

Massee's Plant Diseases.[1] — In an introduction of fifty-three pages the author gives a short general account of fungi, the precautions to be used in preventing and combating diseases caused by them, and details concerning fungicides and spraying. The main part of the volume is devoted to descriptions of the principal diseases due to fungi in all parts of the world, giving the popular and scientific names, simple descriptions of the fungi and the effects they produce on the plants they attack, together with notes on the means of prevention as far as they are known. References are also given, to which the reader is directed for further information. The accounts of the special diseases follow the systematic order of the fungi which cause them, rather than the arrangement followed in some treatises where the

[1] Massee, George. *A Text-Book of Plant Diseases caused by Cryptogamic Parasites.* New York, The Macmillan Company, 1899. Small 8vo, xii + 458 pp., 92 figs.

different diseases which attack any particular plant are grouped together. The numerous illustrations are in general satisfactory. In some cases, as in that of *Phyllactinia suffulta*, they might be improved. The last hundred pages give the scientific descriptions of the fungi treated on previous pages. The *Text-Book* is one which will prove valuable to the student of plant diseases, and to the specialist it is important, since the diseases mentioned are not confined to those of Europe and North America, but include a large number of tropical diseases with regard to which the literature is scattered and often inaccessible. Whether the aim of the author, which, as stated in the preface, is to enable those directly occupied in the cultivation of plants, and with but a limited period of time available for study, to determine the nature of diseases caused by vegetable parasites, is likely to be accomplished seems to us doubtful. The general account of fungi, although good as far as it goes, does not give sufficient information as to the characters of the different orders of fungi and of their relation to each other to enable one who has not already some special knowledge of mycology to follow clearly the descriptions of the different diseases. The work, it seems to us, is adapted rather to those who already have some knowledge of systematic mycology, such as persons connected with agricultural schools and experiment stations, and for them the work is a valuable one.

Hough's American Woods.[1] — Part VIII of this unique series of sections of our native woody plants contains west American species of which, perhaps, the most unexpected are the castor bean, tree tobacco, mission cactus, and desert palm. The remainder of the species, however, are of more than usual interest, and one, the Christmas berry (*Heteromeles arbutifolia*), presents a graining of rare beauty. The descriptive text is preceded by useful flower, foliage, and fruit keys to all of the species thus far represented in the publication.

Notes. — A considerable illustrated paper on the anatomy of *Carludovica plicata* is contributed by Henri Micheels to the current volume of the *Mémoires* of the Société Royale des Sciences de Liége.

[1] Hough, Romeyn B. *The American Woods*, exhibited by actual specimens and with copious explanatory text. Pt. viii representing twenty-five species by twenty-five sets of sections. 8vo, viii + 66 pp. Cards of sections, 176–200. Lowville, N. Y., 1899.

Loesener has issued in separate form a paper entitled "*Plantæ Selerianæ*, die von Dr. Eduard Seler und Frau Caecilie Seler in Mexico und Centralamerica gesammelten Pflanzen," reprinted from recent numbers of the *Bulletin* of the Boissier Herbarium.

In a recently published address delivered in November, 1898, before the University of Catania, Professor P. Baccarini discusses the character and history of the Mediterranean flora.

Productive activity in the biological departments of most of the greater institutions of learning is becoming manifest in the increasing publication of the results of research work in the form of "contributions" and the like. The latest of these is the *Meddelanden från Stockholms Högskolas Botaniska Institute*, of which the first volume, for 1898, contains ten papers dealing with a variety of botanical subjects. Professor Lagerheim has done well for the preservation of these papers in binding them together with a collective titlepage and table of contents.

The very active botanical garden at Buitenzorg has recently commenced the publication of a new *Bulletin de l'Institut Botanique de Buitenzorg*, the first number of which contains interesting data on the organization and work of the garden.

An interesting catalogue of the trees and shrubs in the arboretum and botanic garden at the Central Experimental Farm, at Ottawa, Canada, is published by Dr. Saunders and Mr. W. T. Macoun as *Bulletin 2*, second series, from the Experimental Farm. It shows that of a total of 3071 named varieties which have been tested, 1434 have proved hardy, and 361 half hardy, while 737 have not been planted long enough to warrant an opinion as to their hardiness. With this list as a guide, residents of Canada and our Northern States should be able to increase the number of woody plants employed for the decoration of their grounds with a fair prospect of success.

The geographic source of the principal woody plants of the German trade is discussed by Professor Drude in the last volume of the *Jahresbericht* of the Dresden Society "Flora."

In an article recently published in the *Gärtnerisches Centralblatt* and translated for the September *Bulletin* of the Torrey Botanical Club, Dr. Kuntze argues for the adoption of 1737 as the starting point for generic names in botany, and 1753 for specific names, with

the future exclusion of all publications between Linnæus's *Genera Plantarum* of the former date and his *Species Plantarum* of the latter date.

The morphology, biology, and physiology of the flower of the great Amazon water lily, *Victoria regia*, are treated by Eduard Knoch, in Heft 47 of Luerssen and Frank's *Bibliotheca Botanica*.

A paper on the structure and biology of *Cynomorium coccineum* is reprinted by Baccarini from the *Atti* of the Accademia Gioenia, of Catania.

Three new grasses from North Carolina are described by Ashe in a recent number of the *Journal* of the Elisha Mitchell Scientific Society.

PALEONTOLOGY.

Fossil Medusæ.[1] — A few years ago no one would have suspected that the rocks of the world could ever yield fossil jellyfish sufficient in quantity to warrant the publication of a quarto monograph of 201 pages and forty-seven plates like the present volume. Equally unlooked for would have been the fact that the oldest known fauna, the Cambrian, was to furnish a large part of the species, together with a great abundance of specimens.

Dr. Nathorst of Sweden (1881) first described Medusæ from the Cambrian, and Walcott, in 1891, suggested that the long-known *Dactyloidites asteroides* of Fitch (*sp.*), from the Cambrian slates of New York, might indicate portions of fossil jellyfish. The true affinities of the puzzling Alabama "star-cobbles" were likewise determined by Walcott in 1893, so that gradually both the subject of fossil Medusæ and the material for study grew sufficiently large to necessitate a separate treatment.

The present volume gives a full review of all the known fossil organisms that are now referred to the Medusæ, including both casts and impressions of the body or parts of the animal, and certain trails or markings, such as could be made by dragging the arms or tentacles over the mud of the sea bottom.

[1] Walcott, Charles Doolittle. Fossil Medusæ, *Monographs of the U. S. Geological Survey*, vol. xxx, pp. i–x, 1–201, Pls. I–XLVII. Washington, 1898.

All the undoubted fossil species are classed with the Discomedusæ, and as Haeckel considers this suborder as genetically late in the history of the Acraspeda, their presence in the Cambrian indicates that the differentiation of the class into orders must have taken place in pre-Cambrian time.

There are seven species known from the Cambrian of the United States, Sweden, Esthonia, Russia, and Bohemia. A single species has been noted in the Permian of Saxony, and twelve forms have been described from the lithographic slates of Bavaria. These twenty species, together with two doubtful forms, are described with as much completeness of detail as the preservation of the specimens will permit. Their treatment, as a whole, furnishes the student with a valuable thesaurus of all the available knowledge on the group and a wealth of excellent illustrations.

For a long time the early name of Medusites of Germar (1826) was employed as a generic term to include all fossil jellyfish, but as the original specimens appear to belong to Lumbricaria, Walcott proposes the name Medusina to include all species the true generic character of which cannot be ascertained. Under this term three Cambrian, one Permian, and six Jurassic species are placed, thus leaving but ten species sufficiently well preserved to be satisfactorily defined and classified. Of these ten species six are from the Jurassic of Bavaria and are described under six generic designations. The remaining four species are from American Cambrian terranes and comprise *Brooksella alternata*, *B. confusa*, *Laotira cambria*, and *Dactyloidites asteroides*. The compound nature of Laotira is of unusual interest, especially some specimens of *L. cambria* and *D. asteroides* that indicate occasional reproduction by means of lateral fission. Among recent genera this process is extremely rare.

The giving to indeterminate and unknown markings, mostly inorganic, a binomial nomenclature is quite as productive scientifically as giving generic and specific names to fog and thunder. One such term is "Eophyton," described in 1868 as a plant with monocotyledonous affinities. It has since been enriched by a number of species. Nathorst was of the opinion that many of these fossils represented trails of Medusæ. Walcott concurs in this and supplements it by proving similar markings to be casts of trails of drifting Algæ in shallow water.

C. E. B.

PETROGRAPHY AND MINERALOGY.

The Characters of Crystals.[1] — "I have attempted, in this book, to describe, simply and concisely, the methods and apparatus used in studying the physical characters of crystals, and to record and explain the observed phenomena without complex mathematical discussions" (from author's preface).

The book is divided into three parts and fourteen chapters. The first part discusses the geometrical characters of crystals, the second part the optical characters, and the third part the thermal, magnetic, and electrical characters and those depending upon elasticity and cohesion. In an appendix of seven pages a laboratory course in physical mineralogy is outlined.

While there is nothing new in the presentation or in the subject-matter of the little volume, it nevertheless will be useful as a laboratory manual, since there are to be found in it very concise descriptions of all the methods usually made use of in determining the physical constants of crystals, and in recording the results of angle measurements. In order, however, that it may be of the greatest value to the student, the topics discussed in it should be preceded by a course of lectures in which the principles involved in the descriptions are explained in more detail than has been done in the book.

Many of the methods described are here presented for the first time in English, and for this reason, if for no other, the little volume should meet with a welcome in all mineralogical laboratories. W. S. B.

The First Appendix to the Sixth Edition of Dana's System of Mineralogy, by Edward S. Dana,[2] completes this great work to the beginning of the year 1899. It includes a list of the new mineral names that have been proposed since the *System of Mineralogy* appeared, descriptions of each of the substances indicated by these names, and an account of all the important additions to our knowledge of the species described in the large manual. A vast amount of information is included in the seventy-five pages of the Appendix, and all of it may be depended upon as being trustworthy.

The *System*, with the addition of the Appendix, probably constitutes the most complete summary of a science that exists in any language. W. S. B.

[1] Moses, Alfred J. *The Characters of Crystals. An Introduction to Physical Crystallography.* New York, D. Van Nostrand Company, 1899. viii + 211 pp., 321 figs.

[2] New York, John Wiley & Sons, 1899. x + 75 pp. Price, $1.00.

NEWS.

Dr. Wilhelm von Ahles, professor of botany in the technical school at Stuttgart, has resigned.

Dr. A. B. Meyer, director of the zoölogical and ethnological museums in Dresden, has been in this country studying museum construction and administration. He was sent by the Saxon government.

Mr. J. W. Hendric has given the California Academy of Sciences $10,000 to constitute a publication fund.

At the Marine Biological Laboratory at Woods Holl, Mass., during the past summer the attendance was as follows: investigators, 58; embryology, 21; morphology, 32; physiology, 9; botany, 26; a total of 146.

Recent appointments: Professor W. Branco, of Hohenheim, professor of geology in the University of Berlin. — Dr. Karl Josef Erich Cowens, professor extraordinarius of botany in the University of Tübingen. — Dr. Wilhelm Figdor, docent for anatomy and physiology of plants in the University of Vienna. — Frederick P. Gorham, assistant professor of biology in Brown University. — Dr. James L. Kellogg, of Olivet, Mich., assistant professor of biology in Williams College. — A. F. Stanley Kent, professor of physiology in University College, Bristol, England. — Albert B. Lewis, instructor in zoölogy in the University of Nebraska. — Annie Lyons, assistant in zoölogy in Smith College. — Dr. Johannes Meisenheimer, docent for embryology in the University of Marburg. — Dr. G. Sclavunos, professor of anatomy in the University of Athens. — Dr. Wilhelm Sklarek, editor of the *Naturwissenschaftliche Rundschau*, titular professor. — Dr. Felice Supino, assistant in the zoölogical laboratory of the University of Rome. — Ralph W. Tower, assistant professor of chemical physiology in Brown University. — Dr. Arthur Willey, lecturer on biology in Guy's Hospital, London. — Robert H. Wolcott, adjunct professor of zoölogy in the University of Nebraska. — Dr. Ernst Anton Wülfing, of Tübingen, professor of geology and mineralogy in the Agricultural Institute at Hohenheim.

Deaths: Perez Arcaz, entomologist, in Madrid. — Eugène Gonod d'Artemare, botanist, June 16, in Ussel, France. — Sigismondo Brogi, naturalist, in Siena, July 17, aged 48. — Dr. Karl Bernhard Brühl, formerly professor of zoötomy in the University of Vienna, in Graz, Austria, August 14, aged 79. — John Cordeaux, of Lincolnshire, ornithologist, August 1, aged 68. — Dr. George A. Hendricks, professor of anatomy in the College of Medicine of the University of Minnesota, September 24. — Dr. Oluf Rygh, professor of archæology in the University of Christiania, August 20, aged 66. — Johann Nep. Schnabl, mycologist, in Munich, June 16, aged 45. — Dr. Lawson Tait, well known for his investigations on insectivorous plants, in London, June 13, aged 55. — Dr. Friedrich Thiele, naturalist, in Lochwitz, near Dresden, August 16, aged 85. — Rev. William Farren White, entomologist, in Bournemouth, England, July 21, aged 66 years.

NOTE.

The American Morphological Society will meet with the Society of American Naturalists and other affiliated Societies, at New Haven, during the Christmas holidays. The dates of the meetings are (unofficially) December 27–29. The titles of papers to be presented may be sent to the secretary, Prof. Bashford Dean, Columbia University, New York City.

PUBLICATIONS RECEIVED.

The regular exchanges of the *American Naturalist* are not included.

Dana, E. S. First Appendix to the sixth edition of Dana's System of Mineralogy, completing the work to 1899. New York, John Wiley and Sons, 1899. x, 75 pp., figures. — Davenport, C. B. Statistical Methods with Special Reference to Biological Variation. New York, John Wiley and Sons, 1899. vii, 148 pp., figures. — Korschelt, E., and Heider, K. Text-book of the Embryology of Invertebrates. Translated from the German by Edward L. Mark and W. McM. Woodworth. Part i. Porifera, Cnidaria, Ctenophora, Vermes, Enteropneusta, Echinodermata. London, Swan, Sonnenschein & Co., Limited. New York, The Macmillan Company, 1895. xvi, 484 pp., 225 figs. $4.00. — Korschelt, E., and Heider, K. Text-book of the Embryology of Invertebrates. Translated from the German by Matilda Bernard. Revised and edited with additional notes by Martin F. Woodward. Vol. ii. Phoronidea, Bryozoa, Ectoprocta, Brachiopoda, Entoprocta, Crustacea, Palæostraca. London, Swan, Sonnenschein & Co., Limited. New York, The Macmillan Company, 1899. xvi, 375 pp., 165 figs. $3.00. — Korschelt, E., and Heider, K. Text-book of the Embryology of Invertebrates. Translated from the German by Matilda Bernard. Revised and edited with additional notes by Martin F. Woodward. Vol. iii. Arachnida, Pentastomidæ, Pantopoda, Tardigrada, Onychophora, Myriopoda, Insecta. London, Swan, Sonnenschein & Co., Limited. New York, The Macmillan Company, 1899. xii, 441 pp., 198 figs. $3.25. — Newton, Alfred. A Dictionary of Birds. London, Adam and Charles Black, 1893–1896. Cheap issue, unabridged, published October, 1899. xii, 124, 1088 pp., cuts. $4.00. — Pinchot, Gifford. A Primer of Forestry. Part i. The Forest. Bulletin No. 24 U. S. Department of Agriculture. Division of Forestry. Washington, 1899. 12mo, 88 pp., 47 pls. — Thompson, Ernest Seton. The Trail of the Sandhill Stag. New York, Charles Scribner's Sons, 1899. 93 pp., 60 figs. $1.50.

(*No. 394 was mailed October 20, 1899.*)

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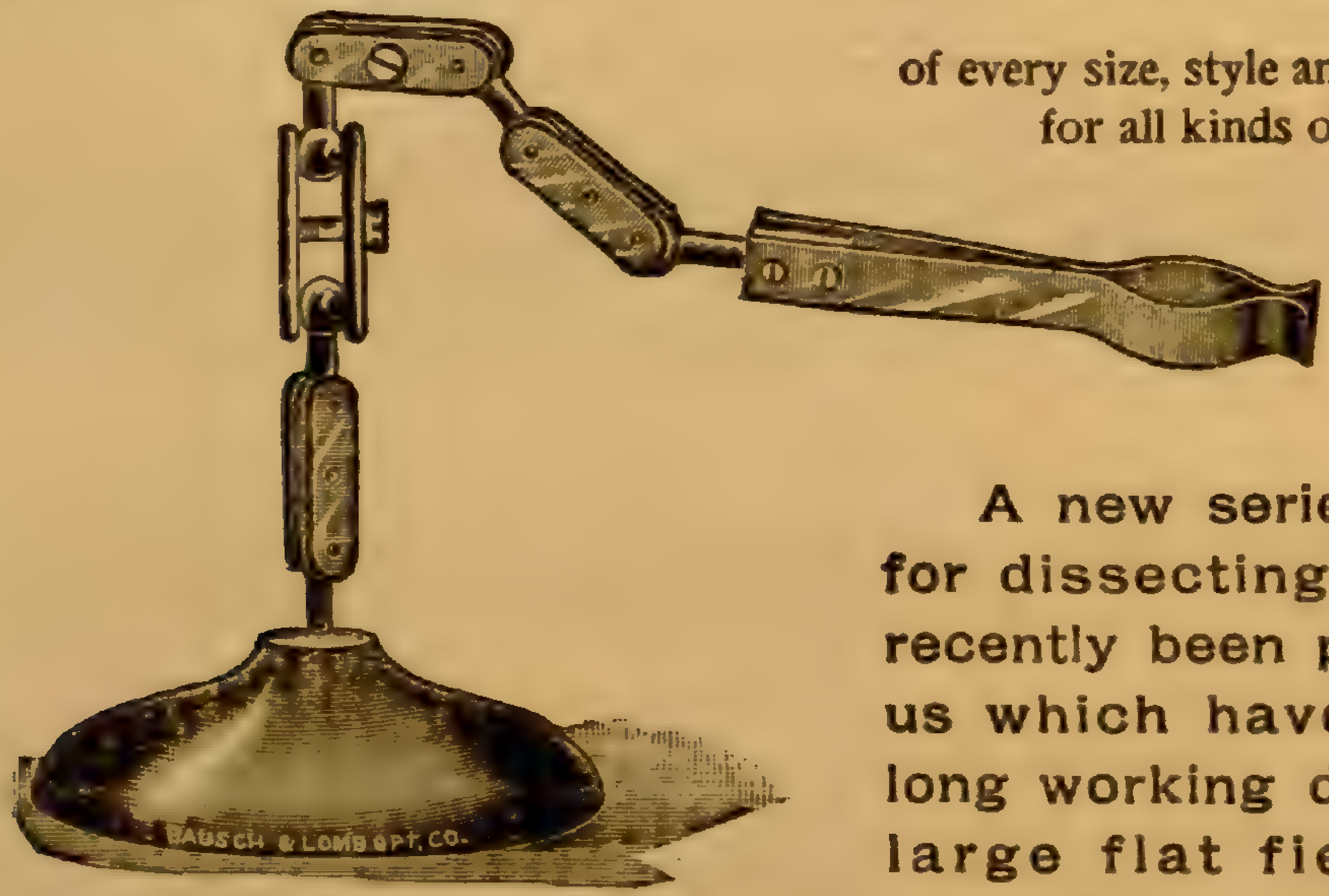

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A MONTHLY JOURNAL
DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE

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FACTS AND THEORIES OF TELEGONY.

HERMON C. BUMPUS.

It will be remembered that Professor Weismann, in a chapter of *The Germ-Plasm*, entitled "Doubtful Phenomena of Heredity," referred to what is generally known as *infection of the germ*, and gave to it the term "Telegony." Although he expressed some doubts as to the existence of the phenomenon, believing that the recorded instances of "infection" were based upon an insufficiency of data or misinterpretation of facts, he felt justified in considering its occurrence *possible*, since supposed cases of infection had been often discussed, and even Darwin had considered the subject worthy of special mention.

The belief that the male of the first coitus may influence the color, structure, and disposition of the young born to a female, of another sire, is almost universally held by stock-breeders, and so tenaciously that even the accidental contamination of a pure-bred female by a male of inferior blood renders her permanently undesirable for breeding purposes.

The question, however, had received no special attention from biologists previous to the Spencer-Weismann controversy

of 1893. At that time Spencer accepted telegony as an incontestable fact, called attention to experiments made by Mr. Nouel upon sheep, and described in the *Journal of the Royal Agricultural Society* for 1853; to others made upon pigs by Daniel Giles, Esq., and reported in the *Philosophical Transactions* for 1821; and to the famous experiment of Lord Morton, in which a nearly full-blooded Arabian mare, having been mated to a quagga, by which she had a hybrid foal, subsequently bore to a full-blooded Arabian stallion two foals, which were said to simulate the markings of the quagga. He concluded: "And now, in presence of these facts, what are we to say? Simply that they are fatal to Weismann's hypothesis. They show that there is none of the alleged independence of the reproductive cells; but that the two sets of cells are in close communion. They prove that while the reproductive cells multiply and arrange themselves during the evolution of the embryo, some of their germ-plasm passes into the mass of somatic cells constituting the parental body, and becomes a permanent component of it. Further, they necessitate the inference that this introduced germ-plasm, everywhere diffused, is some of it included in the reproductive cells subsequently formed. And if we thus get a demonstration that the somewhat different units of a foreign germ-plasm permeating the organism, permeate also the subsequently formed reproductive cells, and affect the structures of the individuals arising from them, the implication is that the like happens with those native units which have been made somewhat different by modified functions: there must be a tendency to inheritance of acquired characters."

Romanes expressed himself more cautiously. While admitting that telegony occurred, he questioned its frequent occurrence, and could not accept Spencer's explanation, nor agree with him that the phenomenon disproved Weismann's doctrine of the isolation of the germ-plasm.

In 1896 Dr. A. L. Bell published an article in the *Journal of Anatomy and Physiology*, in which he described several cases that purported to illustrate the influence of a previous sire, and described several experiments that he had made upon horses

and dogs for the express purpose of producing results which might be attributed to the influence of telegony. In the same year Karl Pearson examined the matter statistically, and showed that in man there was no evidence that the younger children of a family have characters more nearly resembling those of the father than do the eldest, for it is evident that if telegony really occurs the later offspring of the "infected" mother would resemble the father more than would the first-born.

Mr. Bulman has more recently called attention to the bearing that "hybrid-oölogy" has upon the question of telegony. The eggs deposited by a female bird of a certain species, after she has been mated to a male of another species, will often resemble, in their coloration, the eggs of the latter species. This fact, which appears to be well established, has been thought to prove that the sperm influences not the ovum alone, but the walls of the oviduct, which in turn imprint their acquired character upon the eggshell. It seems to the writer, however, that one is not driven to accept such a phenomenon as an instance of "maternal infection." The hen's egg is not the product of the undirected metabolic activity of the hen alone, but is the result of the joint activity of the combined oöcyte and sperm, — the oösperm, — and the coverings of the egg, the membranes and shell, in their elaboration, must be affected as well by the centrifugal influence of the oösperm as by the centripetal influence of the oviducal walls. The egg takes unto itself what it selects, not merely what is thrust upon it.

A paper strongly in favor of telegony, and partially based upon experiments, was written by Mr. Frank Finn, at the time of the Spencer-Weismann controversy, and published in *Natural Science.* The observations therein recorded, especially those upon varieties of the domestic fowl, are exceedingly interesting, and one would almost become convinced, had the experiments been made for the express purpose of securing definite data bearing upon the disputed question, and had adequate precautions been taken for the exclusion of errors. But it is this very lack of definite data, and the frequent admission

of evidence based upon anecdotes and traditions of obscure origin, that have made so many of the communications inconclusive and unsatisfactory. Of an entirely different nature are the efforts of Professor J. C. Ewart of the University of Edinburgh, who has lately published some of the results of his "Penycuik Experiments"; but although his work has received the well-merited attention of the British journals, American publications have been almost shamefully indifferent to its importance.

Professor Ewart began his experiments in 1895, when he secured three male Burchell's zebras. Two of these died, but the third became thoroughly acclimated. This zebra was mated to Mulatto, a black West Highland pony, and the hybrid colt Romulus, born in August, 1896, was even *more profusely striped* than the sire, which in its figure and general behavior it strongly favored. Now, following Lord Morton's experiment, Mulatto was sired by an Arabian horse, and, lo! and behold! like Lord Morton's colt, Mulatto's foal presented a number of stripes, although these were indistinct and visible only in certain lights. A third foal, born to Mulatto in May of the present year by a West Highland pony, Loch Corie, also showed indistinct markings.

It would thus appear at first sight that Mulatto's second and third foals lend support to the belief in telegony, but the Scotch professor did not stop here. Soon after the birth of Mulatto's third foal, two West Highland mares, similar to her, but neither of which had ever seen a zebra, had colts by Loch Corie, both of which were striped. It is thus seen that striped colts may be born to full-blooded parents without the "infection" of a zebra sire, and we are practically forced to give up our interest in the offspring of Lord Morton's mare.

Further experiments of Professor Ewart are as follows: A Shetland mare, mated to a black Shetland pony, had as her first foal a colt distinctly striped. Mated to the zebra, her second foal was the most zebra-like of all of Professor Ewart's hybrids; but when again mated, to a Welsh pony, her third foal, born after she had had an opportunity to become infected by the zebra or its hybrid foal, did not begin to have the conspicuous zebra-like markings of the first foal.

The crossing of Iceland, Irish, English thoroughbred and Arabian mares with the zebra, and the breeding of them subsequently to their own or closely related varieties, failed to afford the slightest evidence in support of the theory of the infection of the germ.

Although the "Penycuik Experiments" were evidently undertaken for the express purpose of proving the truth or falsity of the supposed phenomena of telegony, Professor Ewart struck upon certain by-products of no inconsiderable scientific value. It will be recalled that the existing striped horses are grouped under four species: the quagga (*E. quagga*) of South Africa, the most ass-like, and the one of Lord Morton fame; Burchell's zebra (*E. burchellii*), the species used by Professor Ewart, and occurring on the plains north of the Orange River; the true zebra, or mountain zebra (*E. zebra*), and the Somali zebra (*E. grevyi*) of Northeastern Africa. Professor Ewart is of the opinion that, as far as the coloration is concerned, the last is the most primitive of living zebras, and the colors and markings of the hybrid foals resemble those of this species rather than the color-pattern of their sire. In other words, the process of hybridization results in the resurrection of ancestral characters which have long remained latent, and his experiments show also that even the mere crossing of varieties, or the in-breeding of domestic animals may lead to the production of offspring possessing characters which are to be explained only on the principle of reversion.

Turning to Darwin's *The Variation of Animals and Plants under Domestication*, we read under the caption "Crossing as a Direct Cause of Reversion":

"It has long been notorious that hybrids and mongrels often revert to both or to one of their parent forms, after an interval of from two to seven or eight, or, according to some authorities, even a greater number of generations. But that the act of crossing in itself gives an impulse toward reversion, as shown by the reappearance of long-lost characters, has never, I believe, been hitherto proved. The proof lies in certain peculiarities which do not characterize the immediate parents, and therefore cannot have been derived from them, frequently

appearing in the offspring of two breeds when crossed, which peculiarities never appear, or appear with extreme rarity, in these same breeds, as long as they are precluded from crossing."

Lord Morton's mare was used by Darwin in this chapter, not because of its telegonous young, but because its first foal, the hybrid, had stripes "*more strongly defined and darker than those on the legs of the quagga*." Professor Ewart, not alone by his experiments upon horses and zebras, but by experiments upon pigeons, fowl, and rabbits, has provided an abundance of evidence to prove the correctness of Darwin's views as set forth in this chapter, but he certainly shows that Darwin spoke with insufficient evidence when he said: "There can be no doubt that the quagga affected the character of the offspring subsequently begot by the black Arabian horse." His experiments, moreover, have yielded most welcome information of a definite nature respecting the benign and baneful effects of inbreeding, the unsettled questions bearing upon sterility and the strange phenomena which are associated with the word "prepotency." Both men of science and those interested in the practical occupation of breeding owe a debt of gratitude to Professor Ewart, an obligation that J. Arthur Thomson has acknowledged in a recent article in *Natural Science*, but a testimonial even more fitting would be the adoption of similar lines of research by our numerous and amply equipped agricultural schools and experiment stations. The vexed problems of heredity never will be solved until a great many individuals or institutions seriously undertake experimental breeding.

BROWN UNIVERSITY, Nov. 1, 1899.

A NOTE ON THE PSYCHOLOGY OF FISHES.

EDWARD THORNDIKE.

NUMEROUS facts witness in a vague way to the ability of fishes to profit by experience and fit their behavior to situations unprovided for by their innate nervous equipment. All the phenomena shown by fishes as a result of taming are, of course, of this sort. But such facts have not been exact enough to make clear the mental or nervous processes involved in such behavior, or simple enough to be available as demonstrations of such processes. It seemed desirable to obtain evidence which should demonstrate both the fact and the process of learning or intelligent activity in the case of fishes and demonstrate them so readily that any student could possess the evidence first-hand.

Through the kindness of the officials of the United States Fish Commission at Woods Holl, especially of the director, Dr. Bumpus, I was able to test the efficiency of some simple experiments directed toward this end. The common Fundulus was chosen as a convenient subject, and also because of the neurological interest attaching to the formation of intelligent habits by a vertebrate whose fore-brain lacks a cortex.

The fishes studied were kept in an aquarium (about 4 feet long by 2 feet wide, with a water depth of about 9 inches) represented by Fig. 1. The space at one end, as represented by the lines in the figure, was shaded from the sun by a cover, and all food was dropped in at this end. Along each side of the aquarium were fastened simple pairs of cleats, allowing the experimenter to put across it partitions of wood, glass, or wire screening. One of these in position is shown in the figure by the dotted line. These partitions were made each with an opening, as shown in Fig. 2. If now we cause the fish to leave his shady corner and swim up to the sunny end by putting a

slide (without any opening) in behind him at *D* and moving it gently from *D* to *A* and then place, say slide *I*, across the aquarium at 1, we shall have a chance to observe the animal's behavior to good purpose.

This fish dislikes the sunlight and tries to get back to *D*. He reacts to the situation in which he finds himself by swimming against the screen, bumping against it here and there along the bottom. He may stop and remain still for a while. He will occasionally rise up toward the top of the water, especially while swimming up and down the length of the screen. When he happens to rise up to the top at the right-hand end, he has a clear path in front of him and swims to *D* and feels more comfortable.

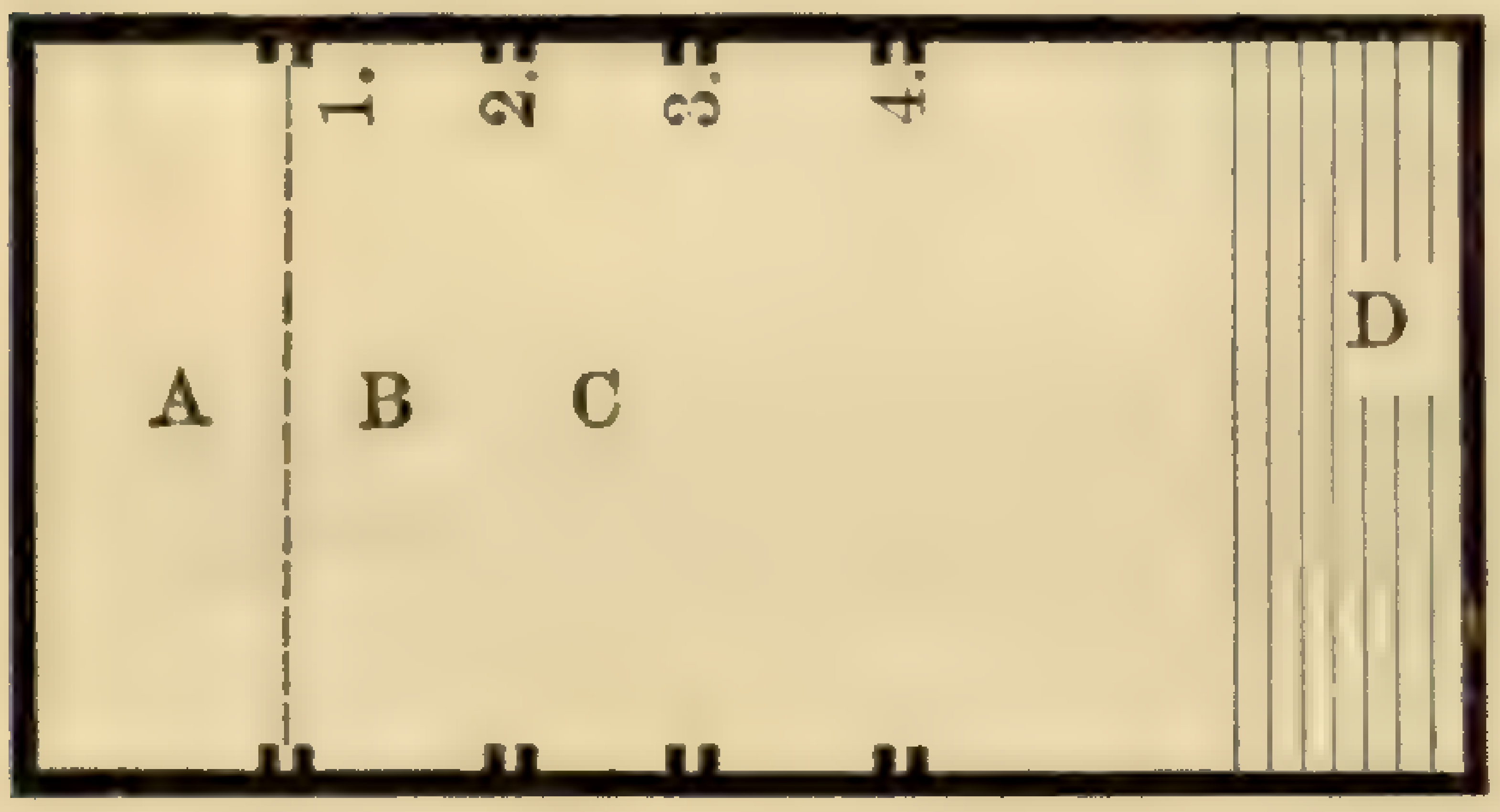


FIG. 1.

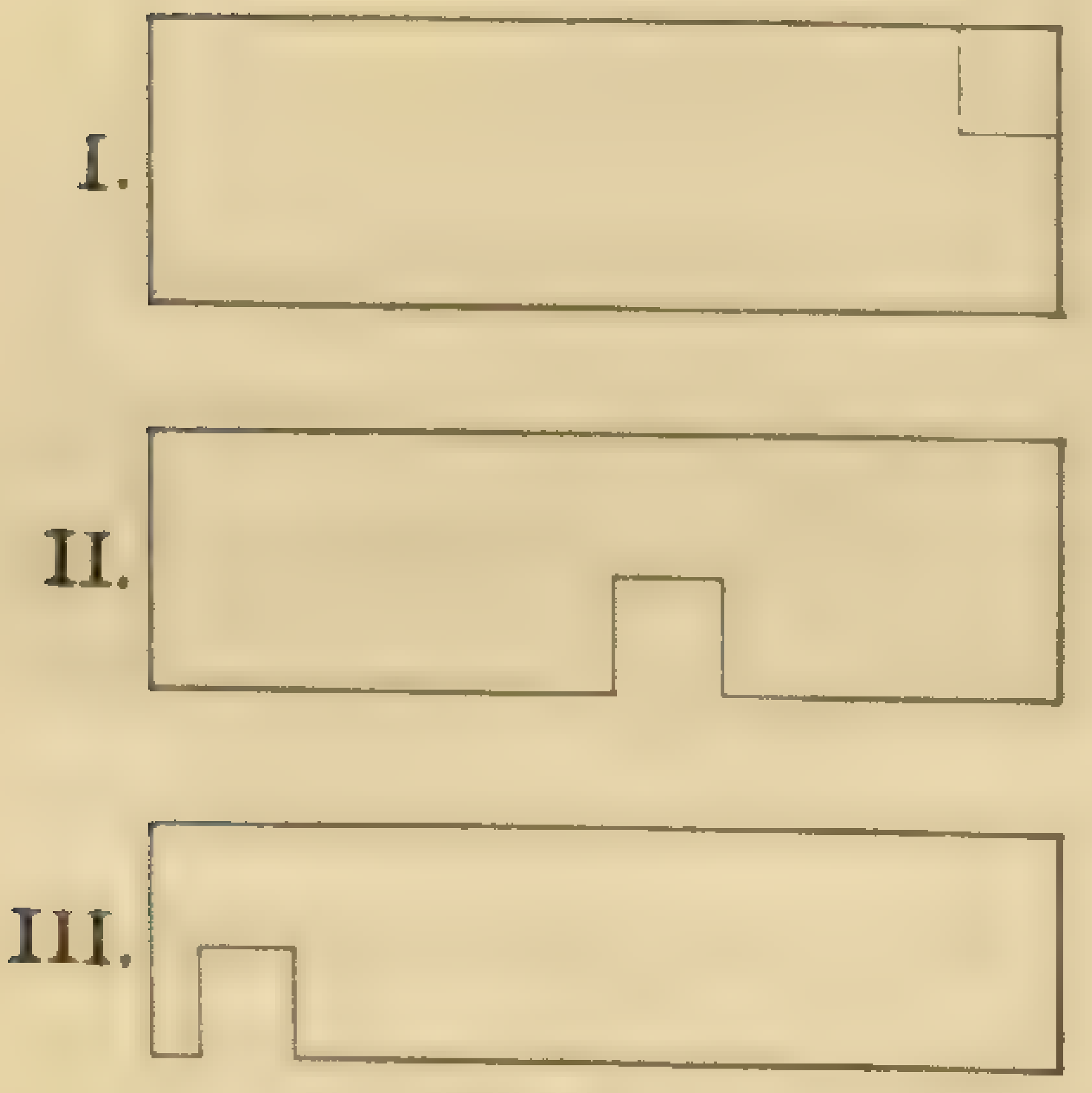


FIG. 2.

If, after he has enjoyed the shade fifteen minutes or more, you again confine him in *A*, and keep on doing so six or eight times a day for a day or so, you will find that he swims against the screen less and less, swims up and down along it fewer and fewer times, stays still less and less, until finally his only act is to go to the right-hand side, rise up, and swim out. In correspondence with this change in behavior you will find a very marked decrease in the time he takes to escape. The fish has clearly profited by his experience and modified his conduct to suit a situation for which his innate nervous equipment did not definitely provide. He has, in common language, *learned* to get out.

This particular experiment was repeated with a number of individuals. Another experiment was made, using three slides, *II*, *III*, and another, requiring the fish to find his way from *A* to *B*, *B* to *C*, and from *C* to *D*. The results of these and still others show exactly the same general mental process as does

the one described — a process which I have discussed at length elsewhere.[1]

Whatever interest there is in the demonstration in the case of the bony fishes of the same process which accounts for so much of the behavior of the higher vertebrates may be left to the neurologists. The value of the experiment, if any, to most students will perhaps be the extreme simplicity of the method, the ease of administering it, and its possibilities. By using long aquaria one can study the formation of very complex series of acts and see to what extent any fish can carry the formation of such series. By proper arrangements the delicacy of discrimination of the fish in any respect may be tested. The artificiality of the surroundings may of course be avoided when desirable.

[1] Animal Intelligence; An Experimental Study of the Associative Processes in Animals. Monograph Supplement No. 8 to the *Psychological Review*, June, 1898.

COLLOPS BIPUNCTATUS AS AN ENEMY OF THE COLORADO POTATO BEETLE.

C. E. MEAD.

On July 20, while searching the potato vines at Aztec, New Mexico, for insect pests, a beetle, *Collops bipunctatus*, was noticed eating a larva of the Colorado potato beetle. The beetle was carefully watched for about half an hour, and with the aid of a pocket lens I could plainly see that fully one-half of the larva had been destroyed and yet the beetle was gnawing contentedly away at the remaining portion.

This specimen was immediately caught for the purpose of confining it with other larvæ of the potato beetle and noting its actions.

After removing the beetle, the vine was carefully examined and found to have on its leaves two clusters of *D. 10-lineata* eggs; one cluster was wholly destroyed apparently by the *C. bipunctatus;* the other, which was yet in good condition, was preserved and placed with a few larvæ of the same species in a box containing the specimen of *C. bipunctatus*. The contents of the box were carefully watched, with the following results:

No sooner had the beetle carefully inspected its new quarters than it began searching the enclosed leaves. After a careful review of these it first proceeded to the ones containing the eggs. Here it began at once to eat the eggs, and continued until it had eaten or destroyed six; then it crawled away and hid itself beneath some leaves in the corner of the box, where it remained in seclusion for about ten minutes. It then left its hiding place and proceeded to where the larvæ of the *D. 10-lineata* were feeding upon some potato leaves. Here it stopped, surveyed its prey, and then attacked a small larva that was by itself at a short distance from the rest. It ate heartily, notwithstanding the protests of the larva, until about one-half of

crop of potatoes of this vicinity is annually saved from the *D. 10-lineata* by the predaceous habits of the *C. bipunctatus*, the presence of which, doubtless, is worth many hundreds of dollars to the potato growers of San Juan County, New Mexico, and maybe to those of elsewhere as well.

San Juan Sub-Station, Aztec, New Mexico,
August 19, 1899.

THE EGG-CARRYING HABIT OF ZAITHA.

FLORENCE WELLS SLATER.

It is a well-known fact that certain bugs of the family Belostomidæ carry their eggs on their back until they are hatched. This has been frequently observed in the case of *Zaitha fluminea*, which is common in the Atlantic States, and with *Serphus dilatatus* of the Western States.

It has been taken for granted by all who have described this habit that it is the female that carries the eggs. And Dimmock even states[1]: "These eggs are set nicely upon one end, and placed in transverse rows, by means of a long protrusile tube, or ovipositor, which the insect can extend far over her own back." Investigation proves, however, that, in the case of Zaitha at least, the credit of carrying the eggs belongs to the male, and that the ovipositor of the female is so short as to make it impossible for her to reach her back with it.

In the course of a study of the reproductive organs and genital armature of Zaitha, made in the entomological laboratory of Cornell University, I have had occasion to dissect many egg-bearing individuals, and in every case they have proven to be male.

The specimens used were collected in the vicinity of Ithaca, where the species is abundant in ponds; and as the egg-laying season lasts from June until the latter part of August, it was easy to obtain material for study. The insects were found most abundantly in shallow water, quite near the shore, clinging to the underside of aquatic plants, especially Marsilia.

The eggs of Zaitha are very large as compared with those of other insects. They number from seventy-five to eighty-five and are placed in regular diagonal rows on the upper side of the wings of the male. This makes a heavy load for the male

[1] *Annual Report of the Fish and Game Commissioners of Massachusetts* (1886), p. 71.

to carry and also deprives him of the use of his wings, confining him to one pond.

That the male chafes under the burden is unmistakable; in fact, my suspicions as to the sex of the egg-carrier were first aroused by watching one in an aquarium, which was trying to free itself from its load of eggs, an exhibition of a lack of maternal interest not to be expected in a female carrying her own eggs. Generally the Zaithas are very active, darting about with great rapidity; but an egg-bearer remains quietly clinging to a leaf with the end of the abdomen just out of the water. If attacked, he meekly receives the blows, seemingly preferring death, which in several cases was the result, to the indignity of carrying and caring for the eggs.

At other times paternal instinct seems to predominate, for with the third pair of legs, which are covered with long hairs, he brushes the eggs carefully to free them from foreign particles. Oftener, however, he vigorously kicks and pushes the eggs. In this way several of the males in my aquarium were successful in dislodging the eggs in a mass; then the hitherto meek, morbid Zaitha darted hither and thither with great rapidity, as if intent upon exhibiting to all the community his regained liberty.

The female is a trifle larger in size than the male and has two small hairy papillæ on the flap covering the genital armature; these are the only external characters which distinguish her from the male.

My observations indicate that the female is obliged to capture the male in order to deposit the eggs. Upon visiting the aquarium one afternoon a male was found to have a few eggs upon the caudal end of the wings. There was a marked difference in the color of these, those nearest the head being yellow, while those nearest the caudal end were dark gray. The small number of the eggs indicated that the female had been interrupted in her egg-laying, and the difference in color of the eggs, that the process must be a slow one.

For five hours I watched a silent, unremitting struggle between the male and the female. Her desire was evidently to capture him uninjured. She crept quietly to within a few

inches of him and there remained immovable for half an hour. Suddenly she sprang towards him; but he was on the lookout and fought so vigorously that she was obliged to retreat.

After this repulse she swam about carelessly for a time, as if searching for food was her only thought. But in ten or fifteen minutes she was back in her first position in front of him. Again there was the attack, and again the repulse. The same tactics were continued until midnight, when, despairing of her success, I left them.

At six o'clock the next morning the entire abdomen of the male and half of the thorax were covered with eggs. Those nearest the head were quite yellow, showing that the struggle had just ended.

RELATION OF THE CHIRPING OF THE TREE CRICKET (OECANTHUS NIVEUS) TO TEMPERATURE.

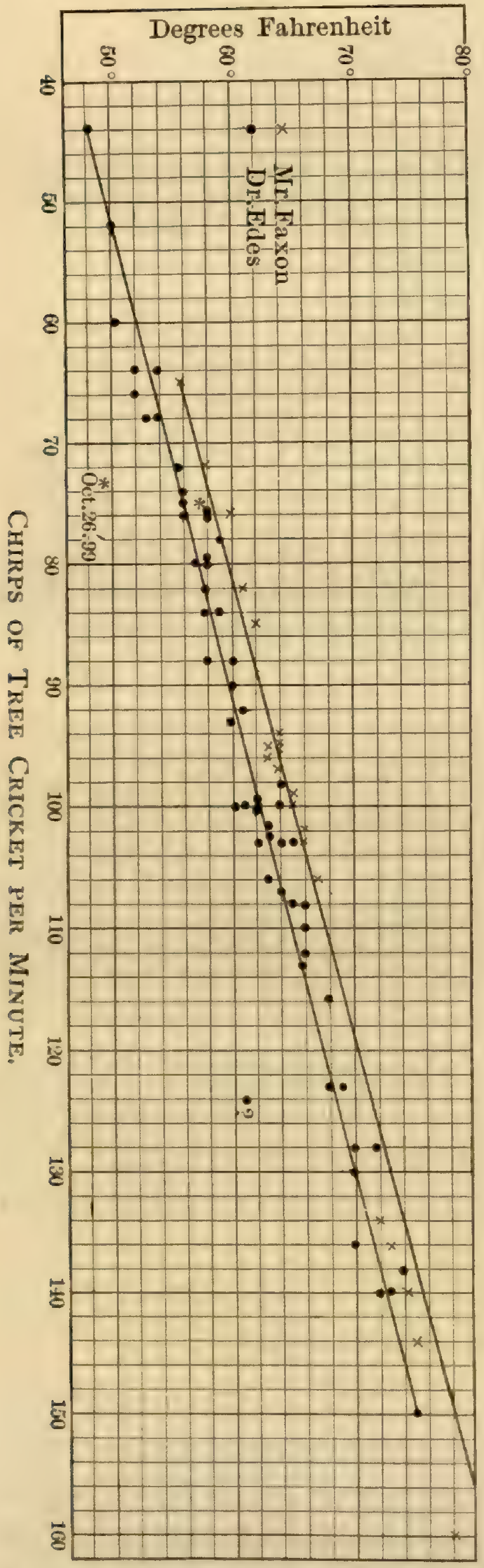
ROBERT T. EDES.

AMONG the shrill insect notes of the late summer and autumn nights, that of one of the crickets is easily to be distinguished from the others by a little attention, on account of its persistency and regularity. From nightfall until nearly daylight his monotonous chirp continues, affected only by weather and temperature, giving one the impression of a close attention to business entirely foreign to the character of careless freedom and irresponsible joyousness attributed to his kindred by the poets from Anacreon down.

Dr. Holmes alone seems to recognize in that "testy little dogmatist," the katydid, one of the same order of insects, a certain tenacity of purpose such as is appropriate to a resident in a less luxurious climate. It would be interesting to know whether this very positive insect is amenable to changes of temperature as quickly as his humbler cousin. In spite of the alleged use made of his relative the "black cricket," by Brian O'Lynn in the song, our friend is not the same personage at all; neither is he the "cricket on the hearth," although Keats recognizes in the latter a susceptibility to the same influences.

> On a long winter evening when the frost
> Has wrought a silence, from the stove there shrills
> The cricket's song, in warmth increasing ever.

As I am informed by Mr. Walter Faxon, the tree cricket (*Oecanthus niveus*) is the source of this persistent and rhythmical stridulation, being much more easily heard than seen, as he lives in leafy shrubs and stops his music when approached too closely. Hence the reader is referred to the Century Dictionary and works on entomology for a description.



A few years ago a note appeared in the *Boston Transcript* calling attention to the very exact dependence of the rapidity of the chirps upon the temperature of the surrounding atmosphere and giving a formula therefor.

In the *American Naturalist* for 1897, p. 970, may be found a brief article, by Professor A. E. Dolbear, also giving a formula, possibly the same. Professor Dolbear makes a claim for synchronism among many individuals which I have not observed, and attributes the phenomenon which he notes rather to the influence of temperature upon the whole orchestra than upon each performer. He says: "An individual cricket chirps with no great regularity when by himself, and the chirping is intermittent, especially in the daytime. At night one may hear all the crickets in a field chirping synchronously."

It seems to me that he may have been deceived by observing two different species, for the tree cricket does not say much in the daytime, but I have certainly located the noise so closely, within a few feet, that I am sure that only one insect was concerned in making it, and it lasted with perfect regularity within several minutes.

Whether the same individual kept it up all night I am unable to say. For several evenings together and for several hours in the same evening I often got a series of chirps from what I suppose to have been a single individual in the same vine.

As to the synchronism, it is true that several performers may be audible at the same time, but the intensity of sound increases rapidly as the individual is approached, so that when all are performing in the same *tempo* the nearest one gives the accent without all the others emitting their notes at exactly the same instant.

Professor Dolbear's formula is as follows:

Let T = temperature in degrees Fahrenheit; N = number of chirps per minute; then

$$T = 50 + \frac{N - 40}{4}.$$ This would give 100 chirps for 65°.

During some weeks this summer I have recorded a number of observations, amounting, with those taken in previous years, to fifty-six, and Mr. Faxon has kindly sent me a series taken by himself.

All three sets and formulæ agree as to the rate of increase, *i.e.*, four beats to a degree, but mine differ from the other two in making the absolute value either two or three degrees lower, as will be seen in the accompanying diagram, in which I have indicated the separate observations of Mr. Faxon and myself, as well as in the tables.

It will be seen that in one-fifth the rule is exact for either 62° or 63° to the hundred, and in four-fifths the error is one degree or less.

One Hundred Chirps Corresponding to	62°	63°
Exact	11	11
Error 1° or less	29	29
Error 2° or less	10	12
Error 3° or less	5	3
More than 3°	1	1

I have little doubt that the errors would be even less if my methods of observation had been more accurate, *i.e.*, chiefly if the thermometer had been in the immediate neighborhood of the performer instead of being on the other side of the house from the vine, whence many of the notes were taken.

It would be very interesting to see whether our "snowy tree cricket" could be induced to give a chamber concert like his black cousin on the hearth, and to try whether an artificial change of temperature would change the rapidity of the music.

To physicians and nurses some interesting comparisons with the rhythm of the pulse as affected by temperature in febrile diseases will be suggested.

REGENERATION IN THE HYDROMEDUSA, GONIONEMUS VERTENS.

T. H. MORGAN.

HAECKEL,[1] in 1870, stated that he found the power of regeneration remarkably developed in several species of medusæ belonging to the family Thaumantidæ. He discovered that if a medusa be cut up into more than a hundred pieces, each piece, provided it contains a part of the margin of the bell, will develop a complete medusa ("*eine vollständige kleine Medusa*"). The little medusa developed in a few (two to four) days. Even a single tentacle, if it contained at its base a small part of the margin of the bell, would make a new medusa. No details are given, and it is not possible to gather from the account whether new organs developed, as one would expect, if the little medusa was complete (*vollständig*), or whether only the medusa-form was assumed by the pieces.

Haeckel also added that if the segmented egg, or even the ciliated larva, was cut up into many pieces, each piece would make a new small larva.

Hargitt[2] described in 1897 the results of a number of experiments that he had made on the regeneration of the medusa Gonionemus. He found that excised portions of the margin of the bell regenerated promptly, but it is not clear in this case whether he meant by regeneration that the cut edges closed together, or whether the parts cut off were replaced. When the medusa was cut into two equal pieces, each became an "independent and perfect medusa." The restoration was somewhat peculiar. "It would seem to be a *recovery* of form and function rather than regeneration in the usual sense of that term." "The new medusæ were in most respects quite simi-

[1] Monographie der Moneren., *Biologische Studien*, Heft 1 (1870), p. 23.

[2] Hargitt, C. W. Recent Experiments on Regeneration, *Zoölogical Bulletin*, 1897, vol. i.

lar in form and action to the original, though of course only about half the size. The time at my disposal was insufficient to observe whether there was subsequent growth of the specimens. In the recovery of the specimens I was not able, moreover, to observe any disposition to regenerate the additional radial canals necessary to complete the symmetry of the original. This, however, does not seem to be an important matter, since there does not seem to be a special necessity for a definite number."

Hargitt also cut the medusa in two in a horizontal plane — one piece being bell-shaped and the other a ring. The former showed evidence in one case of forming new tentacles; the latter produced a new medusa. Referring to the latter, Hargitt states that "the process appeared as more a restoration of form" than the formation of a typical medusa. Neither mouth nor gastric cavity developed. The figure given to illustrate this shows a small medusa with only fourteen tentacles around the margin, while the original piece contained thirty-eight tentacles. The absence of twenty-four tentacles is not accounted for, and is a point of some theoretical interest, since one of the important problems in connection with the development of a small medusa out of the ring is whether the old organs are retained intact or changed over into new ones proportionate in number and size to the smaller dimensions of the new individual. Hargitt also showed that if the manubrium is excised close to the stomach it is regenerated (*i.e.*, a new one develops).

These interesting experiments of Hargitt, although lacking in some details, show clearly that pieces of the medusa as small as one-fourth the whole have a remarkable recuperative power, leading to the production of the bell-like form. The account leaves the question open, whether these bell-like individuals will produce the missing organs if kept for a longer time. My object in studying the process of regeneration in this jellyfish was to find out more definitely by what means it regained its medusa form; whether by the development of new tissues and new organs, or whether by a rearrangement of the old part. Further, to find out if, after some time, the organs of a typical

medusa reappeared, and to examine the behavior of pieces taken from different parts of the body. It was not clear to me exactly what took place, or how the change was brought about; and the results show that the problem is not a very simple one.

Gonionemus has generally four radial canals diverging from a well-defined central stomach. From the latter hangs down a

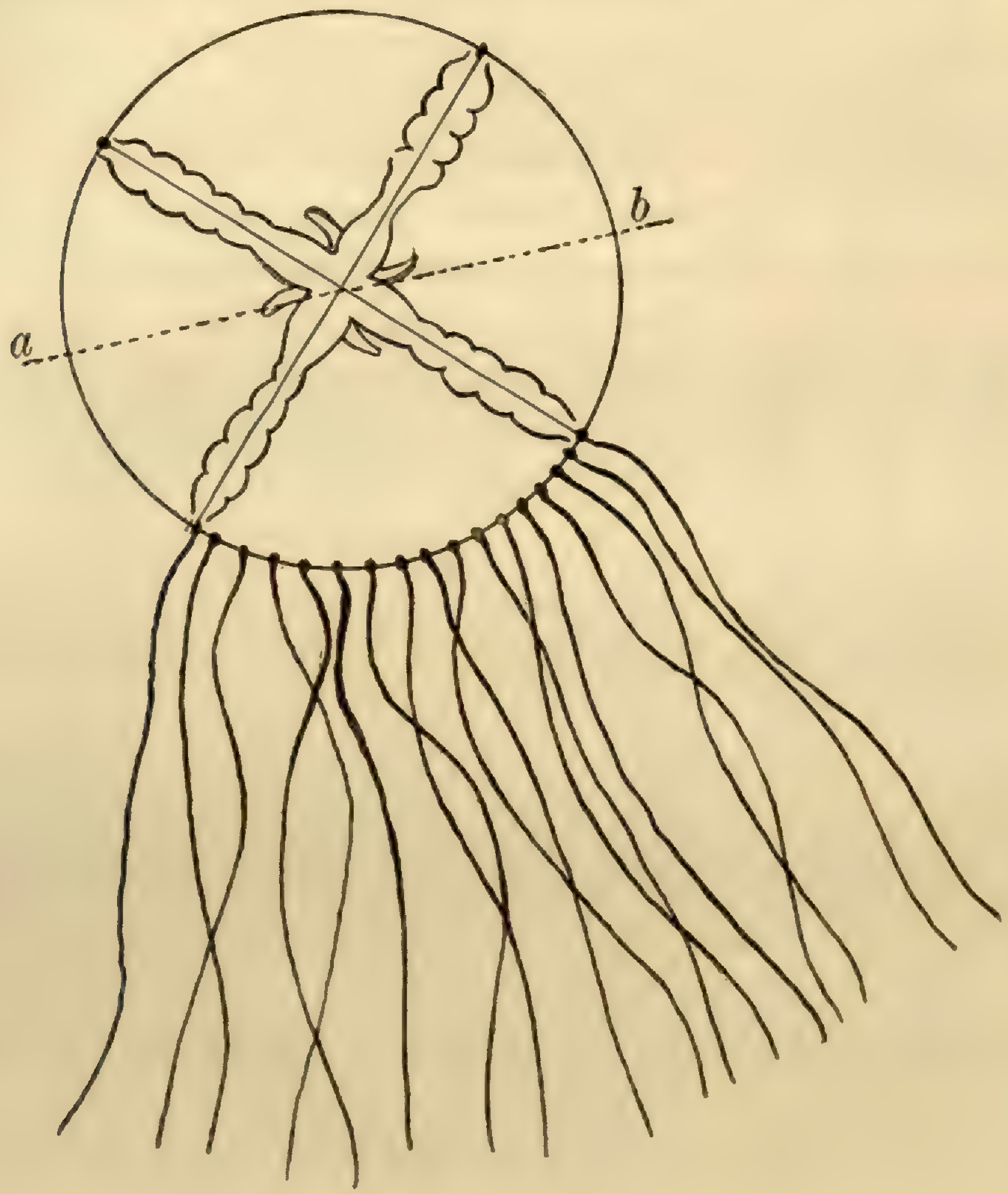


Fig. 1.

short manubrium. The individuals vary in size. I have generally used those of medium and large size (10 mm. to 20 mm. in diameter). The number of tentacles also increases as the medusa grows larger. In a very small individual there were twenty-four tentacles; in one a little larger, thirty-two tentacles; in a larger one, forty tentacles; and in quite a large specimen there were about sixty-four tentacles.

When a medusa is cut in two in a vertical inter-radial plane,

as indicated by the line *a–b* in Fig. 1, the cut surfaces bend slowly inwards and towards each other, and in the course of twelve to twenty-four hours they have met and fused along their entire length. As a result, the semicircle of tentacles now forms a complete smaller circle. The cut edges of the velum also meet, leaving an opening in the center of the velum, as in the typical medusa. The general form of the new individual is like that of the typical form, except on one side the bell is at first less rounded. It can swim about, eat, and I have been able to keep them alive for several weeks. A glance will show, however, that a typical medusa like the one from which the piece was taken has not been formed, for only two radial canals are present that extend out from the stomach (Fig. 2). The latter does not lie at the top of the subumbrella space, but somewhat to one side (Fig. 3). From the stomach arises a new manubrium. If the old manubrium was cut in half when the medusa was divided, each half makes a complete manubrium ; but if, as is often the case, the cut passed to one side of the original manubrium, then one piece retained the old manubrium, and the other piece developed an entirely new one.

FIG. 2.

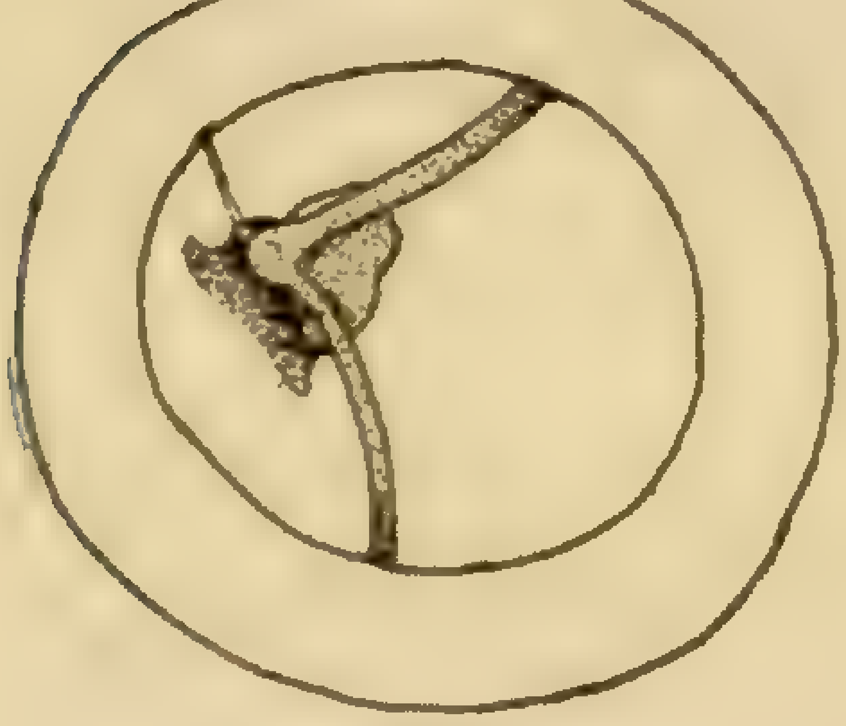


FIG. 3.

Along the line where the cut edges fused together a scar is present that resembles somewhat a third radial canal, but the third canal did not develop, although in some cases a short diverticulum may extend from the stomach for a short distance along this line. If the tentacles be counted after the operation, and then again when the piece has healed, the number will be found to be the same, and this holds true for several weeks. It is possible of course that a few new tentacles may develop, since they develop also in the normal individual as it

grows larger. Occasionally one or two new tentacles are found in the region where the parts have united, but as a rule I have not noticed any increase in the number.

If a medusa be cut into four parts, each containing one of the radial canals, then each piece gives rise to a small medusa-like individual. The cut edges come together and fuse ; the tentacles form a circle, and a velum is also formed with an opening in the middle (Figs. 4 and 5). The new manubrium arises from one side of the bell (Fig. 4), and not from the top of the subumbrella space. Its point of origin is determined by the position in the new individual of the portion of the original stomach. During the process of fusion of the cut edges the proximal end of the radial canal is carried in some cases far over to one side of the new bell. In such a case the manubrium appears to arise just inside of the line of tentacles. In other cases the proximal end of the radial canal is not carried so far, and in such cases the manubrium hangs down from higher up in the subumbrella space. While the form of the one-fourth medusa has in general the typical bell-shape, yet such individuals have only one radial canal and an eccentric manubrium. It may be thought that the process up to this time is only one of healing, and that later the missing parts would regenerate. In the hope of seeing if this were true, I kept alive some of these medusæ for several weeks, and although they seemed to be in excellent condition, yet they did not show the least sign of regenerating the organs that make a complete medusa.

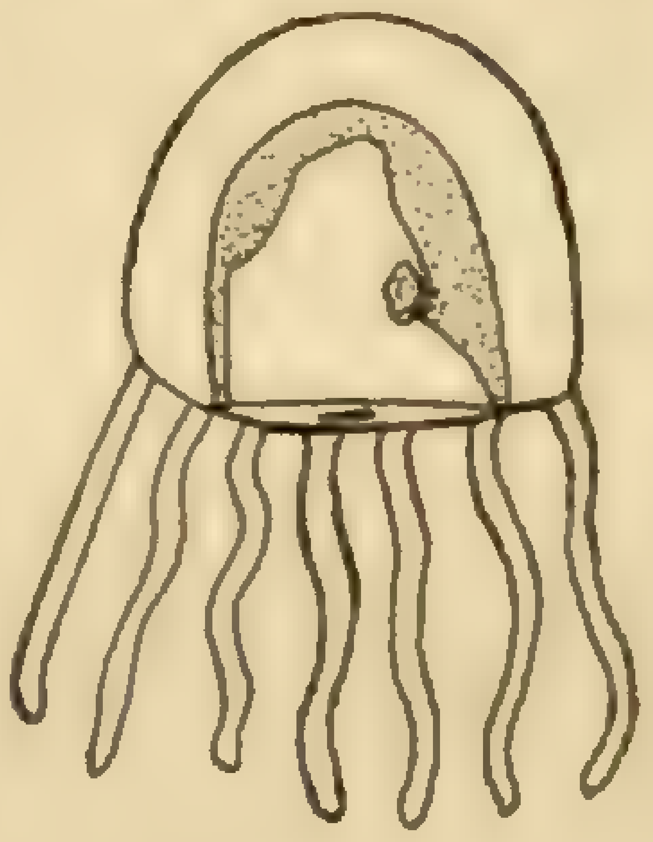


FIG. 4.

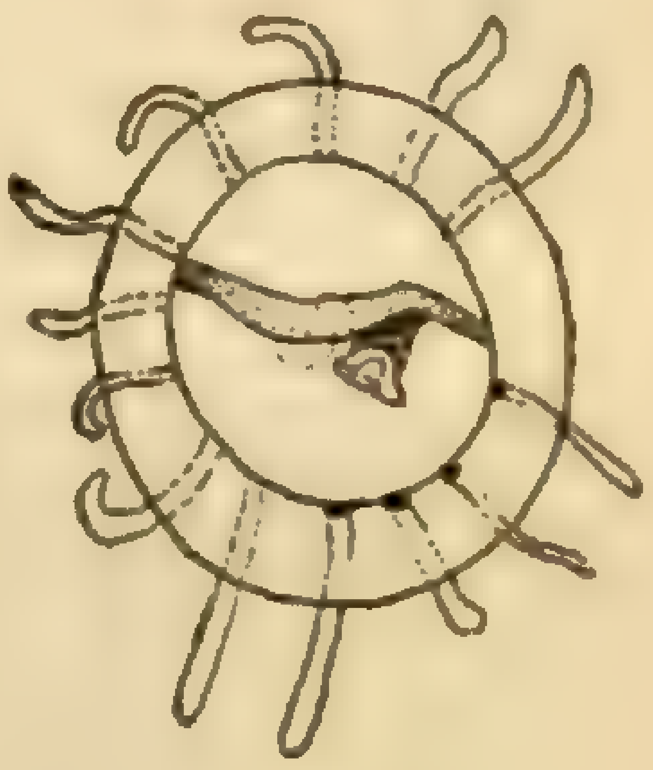


FIG. 5.

These experiments suffice to show that while the healing power of the one-half and one-fourth fragments is very great, yet the regenerative power is not well developed, for neither do the old parts change over into new ones having the typical arrangement (except in so far as the medusa-form is produced), nor do the missing parts regenerate (except the regeneration of a new manubrium) where the edges have healed together.

If only one quadrant is cut out, the larger part (three-fourths piece) forms a medusa having three radial canals and three-fourths the number of tentacles.

Other experiments were made to see if smaller pieces than one-fourth would develop into the form of medusæ. These smaller pieces were cut off in different ways and from different parts of the medusa. If the jellyfish is taken from the water and laid on its side on a glass plate, a portion of one side may be easily cut off in the way indicated by the line *a–b* in Fig. 6. A piece cut off in this way will contain only a part of one radial canal, but somewhat more than one-fourth of the margin with its tentacles (approximately one-third in this case). If the plane of division is less oblique, as indicated by the line *c–d* in Fig. 6, then the entire piece in all its parts is smaller than one-fourth the entire medusa. In both experiments a small bell-shaped individual develops from the piece. The new manubrium regenerates from the cut end of the radial canal, and lies to one side of the new medusa. This shows that a new manubrium may develop from the radial canal some distance from the original stomach.

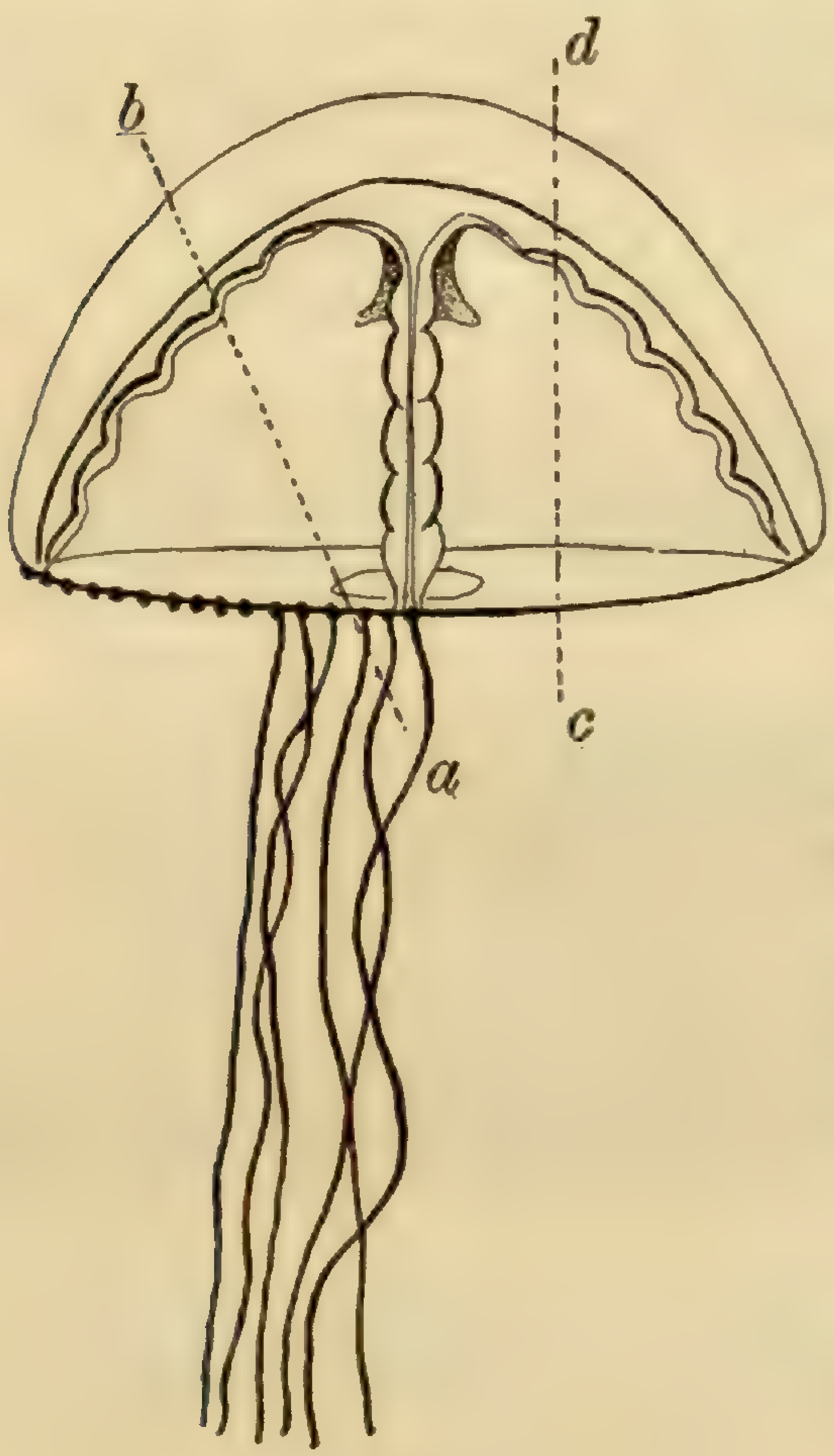


FIG. 6.

Small pieces were also removed in another way. The proximal part of the bell was cut off from the distal part, as shown by the line *a–b* in Fig. 7. Then the distal ring was cut up into smaller pieces, as indicated by the vertical lines in the same figure. In one case the ring was cut into four equal parts, each with a part of a radial canal. The pieces closed in, but somewhat imperfectly, and although they were kept for twenty

days they did not assume the typical medusa-form. In another case the distal ring was cut into eleven pieces. Four of the pieces contained the distal end of a radial canal; the rest did not contain any part of the radial canals. About half of the pieces showed later little resemblance to the medusa-form. They became swollen and irregular, and although kept for twenty days did not develop further. Other pieces became somewhat bell-shaped, but in none of them was the medusa-form well developed. These pieces seemed, therefore, to be near the lower limit of size necessary for the formation of even the medusa-form, although it is possible that even smaller pieces of a different shape might produce the characteristic form.

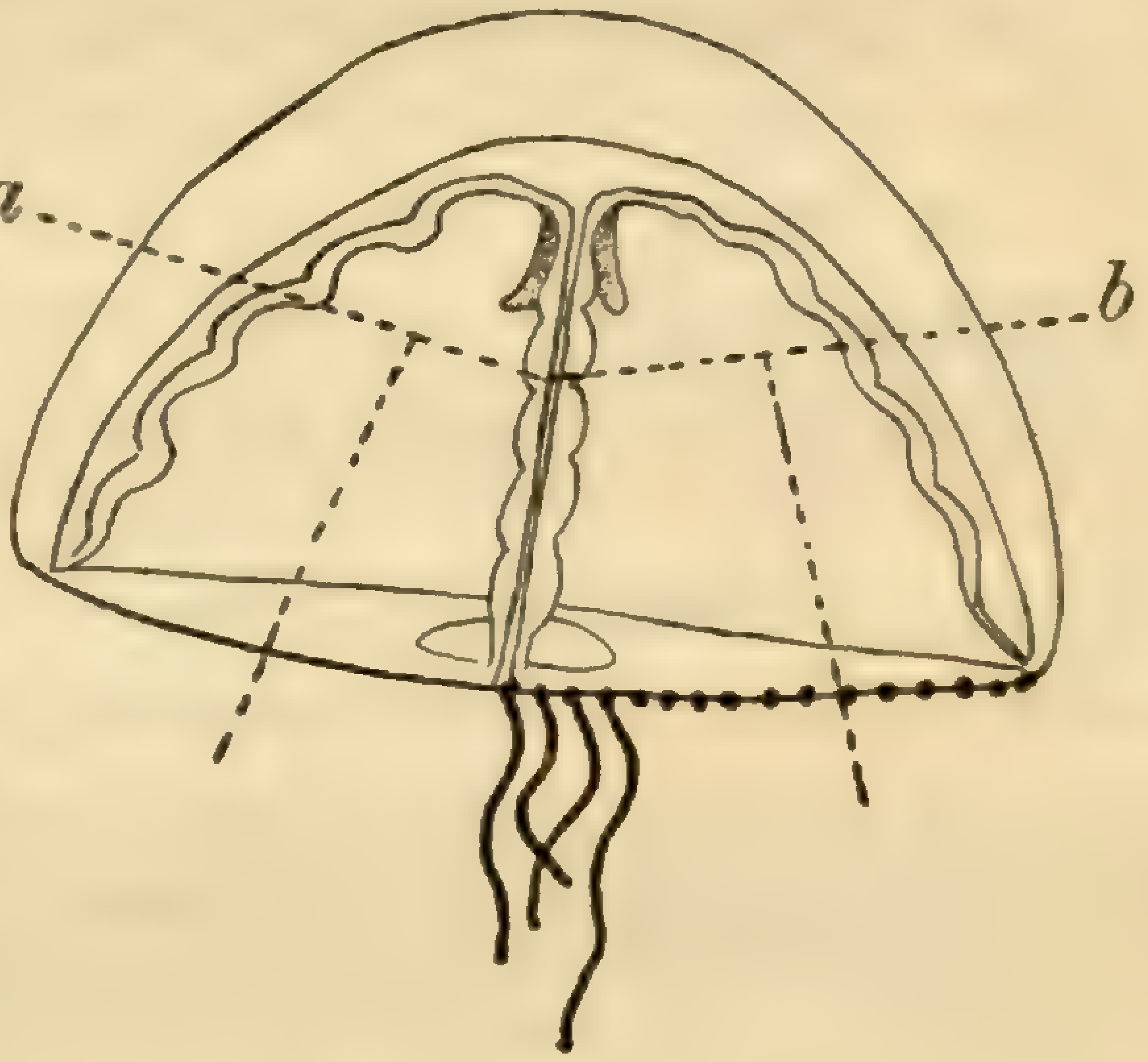


Fig. 7.

The following experiment was made to see if, in the absence of a definite structure such as the radial canal, a piece might regenerate a new radial system having the typical form. A jellyfish was placed oral side down on a glass plate, and with a knife, or with scissors, an inter-radial piece triangular in outline was cut out (Fig. 8, *A*). A piece of this sort does not contain any part of the central stomach or of the radial canals. It contains a part of the endoderm in the form of a plate extending throughout the middle of the piece, and a ring canal around the margin. In all, forty-eight pieces of this kind were cut out. Most[1]

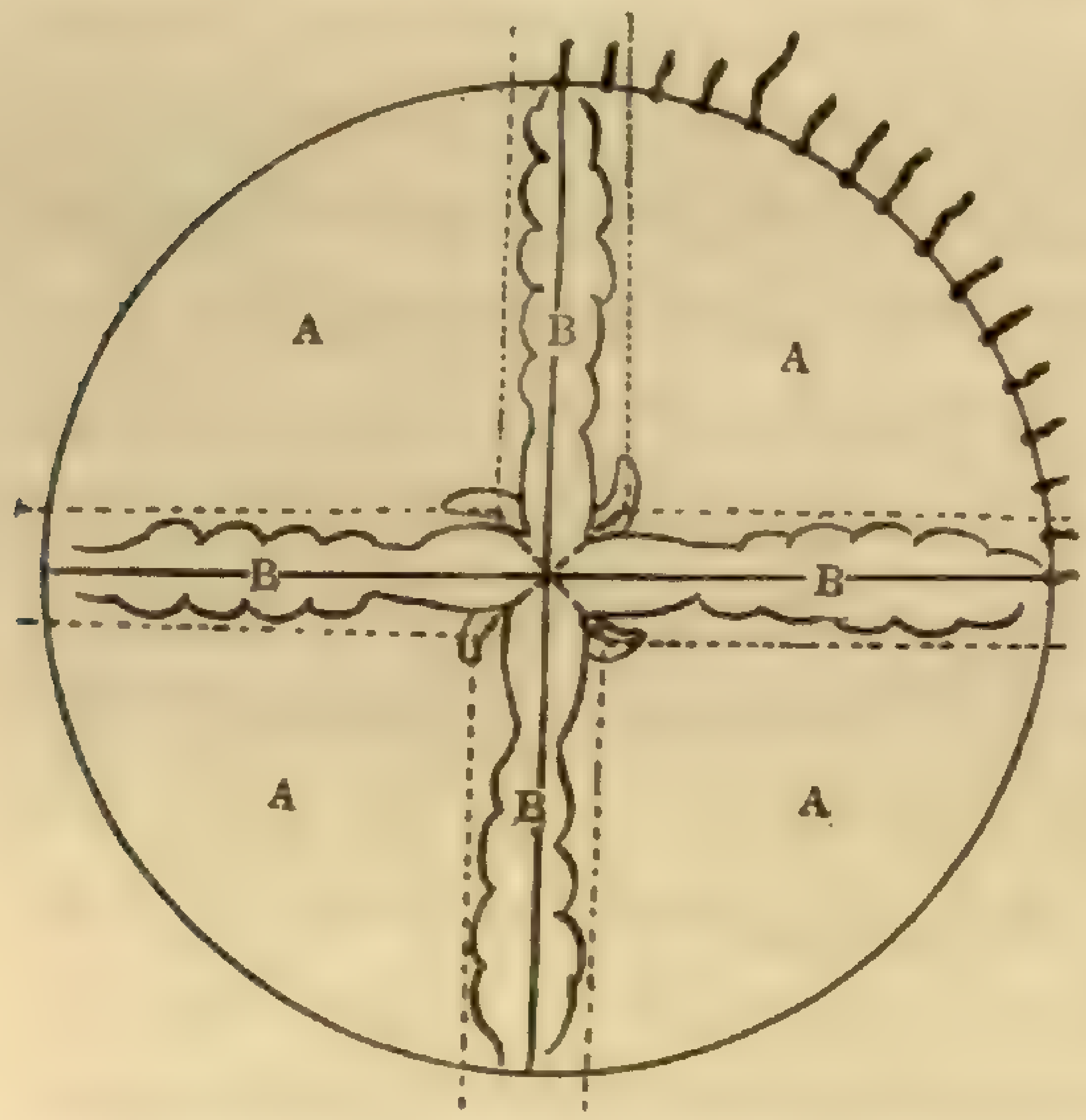


Fig. 8.

[1] Some of them died, especially in one experiment, due to too many being kept in the same dish.

of the pieces closed in and the old tentacles formed a ring encircling the margin. The piece assumed, in a general way, the form of the medusa (Fig. 9), and from the middle of the lower side a proboscis-like outgrowth developed (stippled in the figure). In the center of the bell two cavities are present. In order to interpret these structures it was necessary to make serial sections. The sections show that the larger cavity (stippled in the figure) represents the subumbrella space, and is therefore lined by ectoderm. This ectoderm continues down into the proboscis-like structure of the lower side. The outer surface of this structure is covered by the outer ectoderm. It represents, therefore, not a new manubrium, but a tubular outgrowth of the velum, the latter having completely closed over the lower surface. The outgrowth is fringed along one side and might easily be taken for a new proboscis, but sections show, in the clearest way, that it does not represent that organ. The other cavity seen in the figure lies on the side where the piece closed in. It represents an enlargement of the ring canal and is continuous with the ring canal around the base of the tentacles. The results show that the small piece, while assuming the form of a bell, is completely lacking in the essential organs of the medusa.

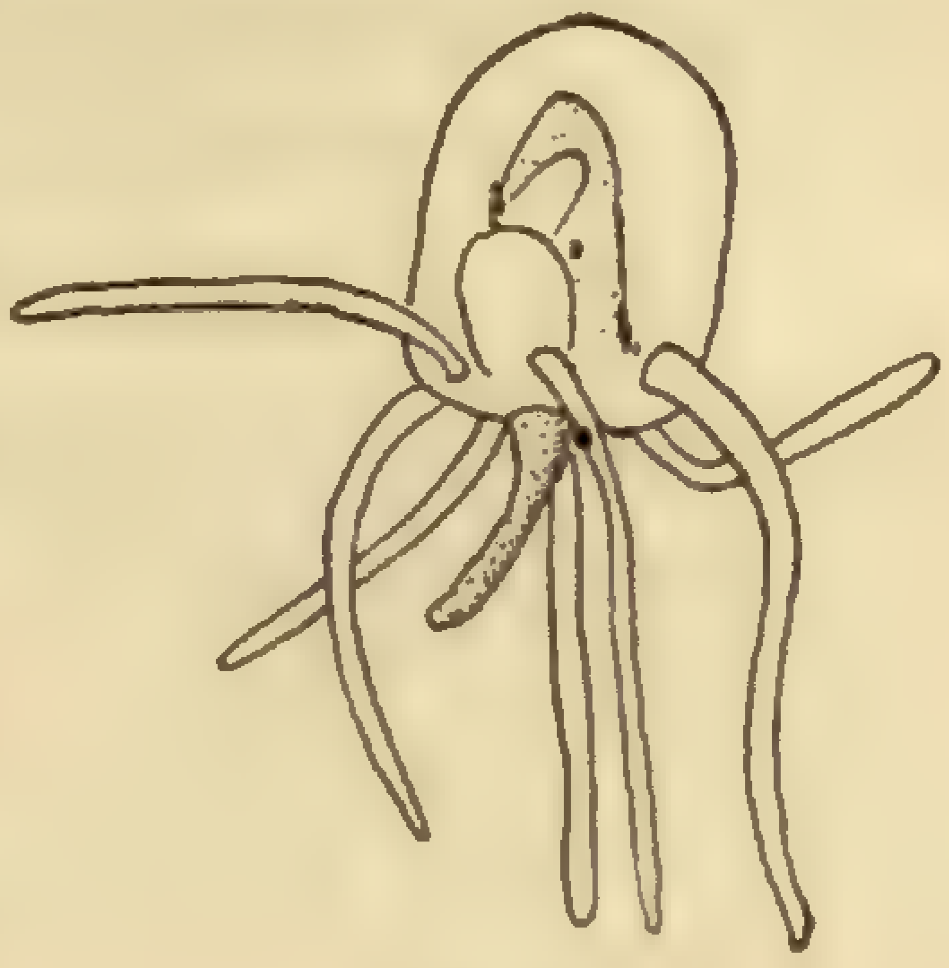


FIG. 9.

FIG. 10.

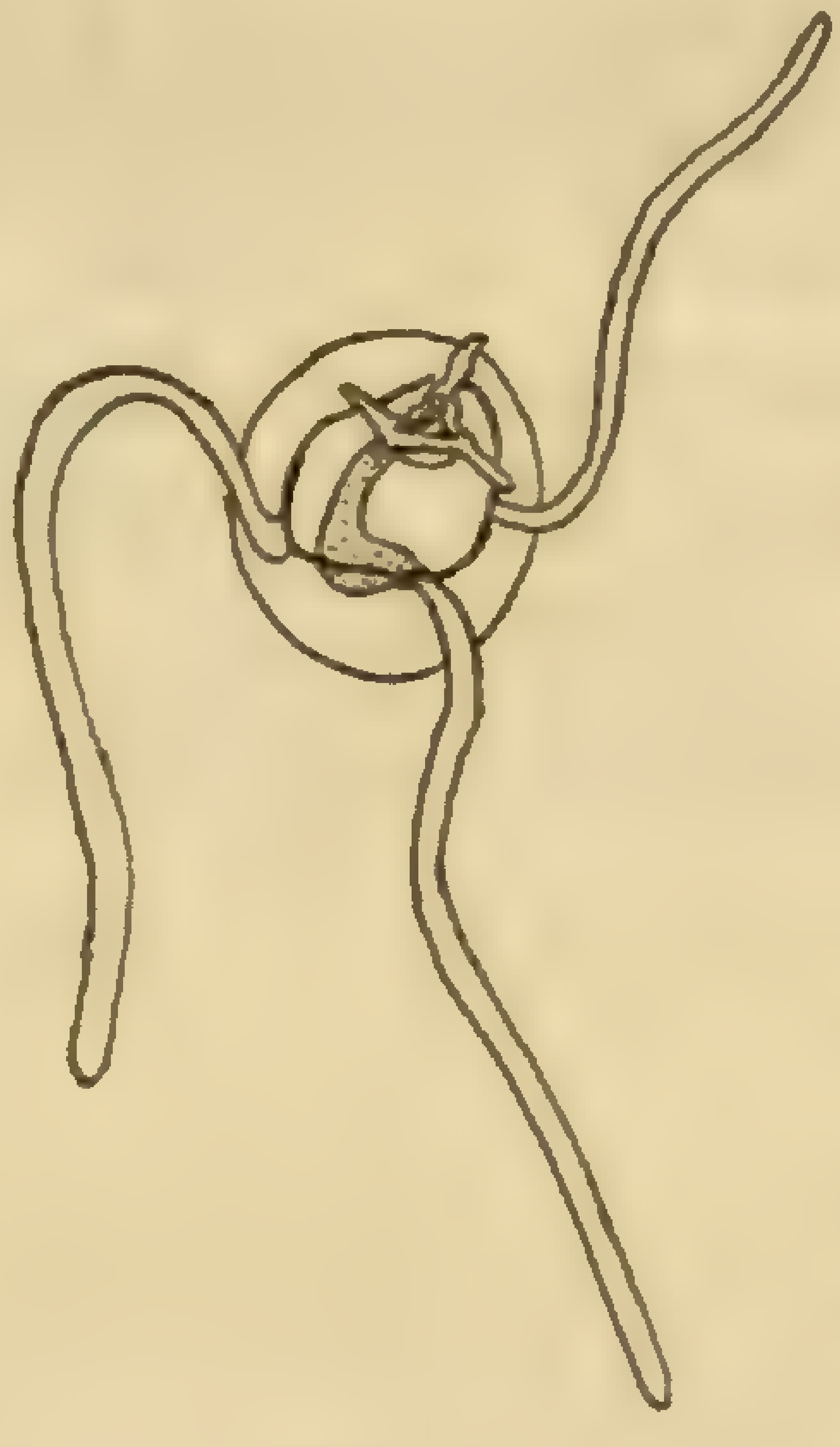


FIG. 11.

In this same experiment the cross-shaped piece that remained after the four triangular pieces had been removed was itself cut into four pieces through the stomach (Fig. 8, *B*). These small pieces sometimes developed into medusa-like forms, each with a manubrium, but did not reproduce the other missing parts (Figs. 10 and 11).

Quite a number of experiments were made at different times

to see if the proximal end of the bell, with its contained organs, *viz.*, the stomach, manubrium, and the proximal ends of the radial canals, could develop a new circle of tentacles, sense-organs, etc. Hargitt has described one case in which there was some evidence of the development of new tentacles, but the piece died without further development.

In this experiment I cut off the proximal bell portion, sometimes by cutting around with a pair of scissors, sometimes by laying the jellyfish on its side and cutting off the margin with a knife.

Some of the proximal pieces were small, some large, some had been cut off by a nearly circular line, others by two or three oblique lines. In most cases the bell portion contracted, after a day or two, around the base of the manubrium, but no further development took place. In other cases the cut edges met and fused to form a sphere entirely closed. These kinds of pieces disintegrated after several days. Forty pieces in all behaved in one or the other way. It will be noticed that in nearly all these cases the part removed had been cut off less than halfway down the side of the bell, or near that level. It occurred to me that if the margin of the bell were cut off not so high up as before, but farther down, better results might be obtained, both because larger proximal pieces would result, and also, the cut edge being nearer to the old tentacles, the new ones were more likely to develop. In thirteen individuals the margin was removed as just described. Two of these showed, five days after the operation, small opaque projections around the margin of the cut edge. In one of these (Fig. 12) there were twenty of these small knob-like bodies. Although these grew somewhat more distinct and slightly larger during the next day or two, they failed to develop further. These two cases are similar to the one described by Hargitt. He attributed the failure of the knob-like projections to develop into tentacles to the unprecedented hot weather that prevailed at the time. But although I kept one of the two pieces for

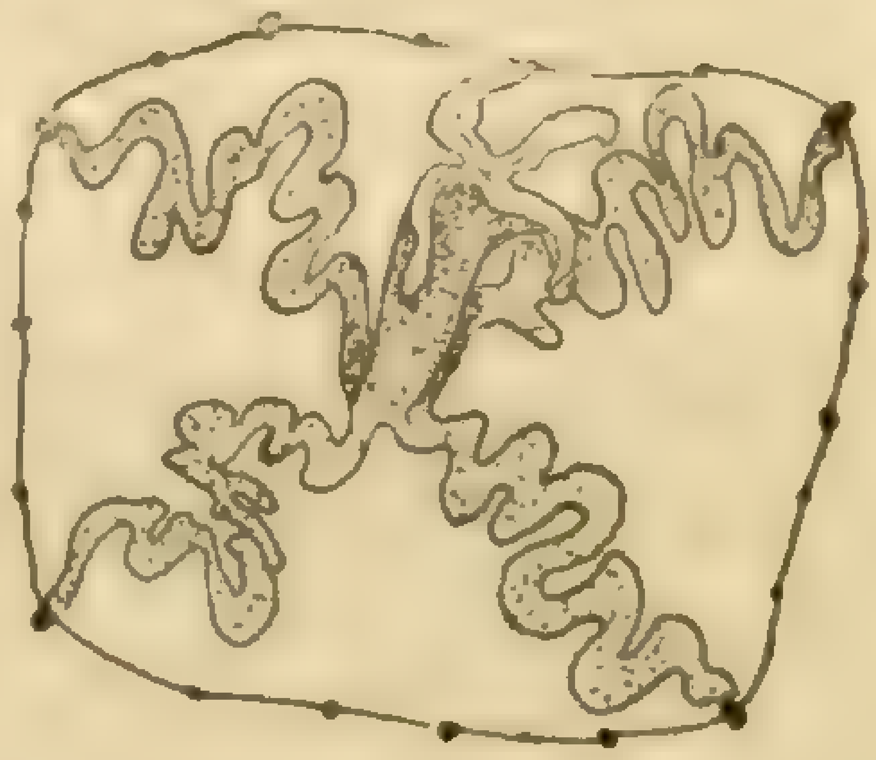


FIG. 12.

a week or more after the knobs appeared, they failed to develop. Considering the large number of experiments that I have made, I am inclined to think that Hargitt overestimated the capabilities of pieces of this sort. The result, it seems to me, follows only when the cut has been made near the margin of the medusa. The peripheral rings that had been cut off in the preceding experiments, fifty-three in number, were kept alive to see if, as stated by Hargitt, they too would give rise to medusæ. All those pieces from which a large part of the bell had been removed failed entirely to close in, and died after a few days. It seems that under very favorable circumstances a piece from which only a small proximal part has been removed may again develop into a complete medusa, and in fact, in one or two cases, this seemed very nearly accomplished. In one case a new stomach formed, and a very small manubrium; in another case the proximal ends of two of the canals united, and a small manubrium developed, but lay somewhat eccentric in position. The difficulty seems to be in the closing in of the ring rather than in the regeneration of a new stomach and manubrium. This is shown by the following experiment:

In several cases I cut out from the oral side the entire stomach and its attached manubrium, as well as the immediate proximal ends of the radial canals. Care was taken to remove completely all the endoderm in this region, but the cut did not pass through the jelly of the bell. I hoped to see if, under these circumstances, a new stomach and manubrium would develop, or if from each of the proximal ends of the radial canals a single manubrium would sprout forth. The latter possibility would seem to exist in the light of the experiments on the one-half and one-fourth pieces. If, on the other hand, a new stomach and a single manubrium developed, this would seem to indicate some sort of interrelation of the parts with one other (the canals are, of course, connected by a plate of endoderm). The endoderm grew forward over the region previously occupied by the stomach, and out of it was formed a stomach from which a new manubrium grew out.

It has been shown that in the one-half and one-fourth

medusæ the new manubrium develops always from the cut end of the radial canal. It often lay far to one side of the center of the new bell. I tried in another experiment, cutting in two the radial canal in the one-fourth piece at the middle of the canal, *i.e.*, at a point that would correspond approximately to the middle of the new bell. Under these conditions it was possible that a new manubrium might develop at this point, rather than at the other proximal end of the tube. This result did not follow, however, since, at the cut, the ends came together and fused. The experiment might succeed if the cut ends could be kept apart, or if a short piece were cut out of the canal at some point.

Finally I cut off the rim with its tentacles from three of the four quadrants, leaving only one quadrant entire. The experiment was made to see if, when a part of the rim was left, it might give rise at its free ends to the missing part of the ring, or possibly, under these conditions, the injured part of the rim might more readily produce new tentacles. The medusa closed in so that the opening into the subumbrella cavity became quite small. The opening was surrounded for the greater part of its extent by the tentacles of the uninjured quadrant. Over a small region no tentacles were present at first, but after five days a few new ones appeared. They were not more numerous near the ends of the uninjured part of the ring than elsewhere. The result is similar to that in which the entire margin is cut off (Fig. 12), although in this case the new tentacles were better developed.

The results of these experiments show, for Gonionemus at least, that Haeckel's statement, that even the smallest pieces may make new medusæ, is not correct ; for although pieces somewhat smaller than one-eighth of the medusa may make new individuals having the medusa-form, yet these small individuals, as well as larger ones, lack the most essential features of the medusa. The remodeling extends only to the form of the entire piece and does not include the internal organs.

It is puzzling to determine whether the medusa-form assumed by the pieces is simply the form that necessarily results after the fusion of the cut edges, or whether the process includes

something more than this. When I recall how similar in form the small medusæ are, coming as they may from pieces of very different shapes, I am inclined to believe that there is something more in the process than only the fusion of the cut edges, and that the piece does in reality mould itself into the medusa-form, as Hargitt pointed out.

The further question suggests itself for consideration: Is the process by which the edges bend in and ultimately fuse simply a mechanical result depending upon the tensions set in play when part is cut off? I think not, at least not entirely. The bending takes place very slowly, and not quickly, as would be the case were it simply a roughly mechanical process. The form of the piece continues to change even after the edges have met and fused, pointing, I think, to the conclusion that the entire process is one of rounding up of the piece in the direction of least resistance.

The meeting of the edges may sometimes be due simply to an accidental meeting of the bent-in portions, but generally the process is a more orderly one, and of such a sort that it seems to be correlated with the process of remoulding. The fact that the cut edges always succeed in finding each other, even in very unsymmetrical pieces, shows that something more than a gross physical process is at work.

If we attempt to analyze the process so far as is possible at present, we can, I think, make out the following factors. The bending in, taking place in the piece as a whole, seems to be the result of active changes in the living tissues. This leads to the piece assuming more and more the typical form. The meeting of the edges may be due sometimes to accidental contact resulting from the bending in of the piece, but more often the closing of the cut surface is due to a sequence of well-defined events. At some point where two cut edges make an angle with each other they begin to draw together at the angle. The process proceeds from this point until, step by step, the complete fusion is brought about. It is as though, first at the angle, the parts that are continuous around the angle draw together, and the edges coming together fuse. Then new parts that are brought up to the new angle repeat

the process until the entire cut edges are drawn together. There is no evidence that parts widely separated attract each other across the intervening region, as in cases of cytoplasm described by Roux. The cytoplasm is confined to those parts in contact, or at any rate so near together that they may be connected by protoplasmic processes.

I have said enough to show that the process by which the piece closes in is a complex one, in which several factors take part. It is towards the discovery of these simpler processes that take place during regeneration that we can at present, I think, most profitably direct our attention. For if, as appears to be the case, many components enter into the process that we call regeneration, we can only hope to understand the phenomena as a whole when we have resolved it into the immediate simpler factors of which it is made up. Then no doubt we shall find out that we can in turn resolve these factors into simpler ones, and our analysis will be carried a step farther. As long as we interest ourselves with the facts and factors of regeneration the work is not likely to come to a standstill, but when we leave the analytical method and attempt to construct injudicious theories that make the pretense of explaining a complicated process without attempting to resolve the process itself into its factors, then progress stops. Such, I believe, to be the case in the attempt to explain the process of regeneration by a theory of preformed imaginary germs. A theory of this kind is only a pretense; imagination takes the place of verifiable hypothesis, and the process that we set out to study is explained by saying that there are "germs" present that have been set aside to bring about the result!

SALVIA COCCINEA, AN ORNITHOPHILOUS PLANT.

RICHARD C. McGREGOR.

SOME time ago my attention was called to an Anna's Humming Bird (*Calypte anna*) visiting the flowers of a small garden shrub. Feathers at the base of the upper mandible were thickly covered with a yellow substance, undoubtedly pollen; something which I had not previously noticed in the hummers. The question was at once suggested, Does this plant depend upon birds for cross fertilization?

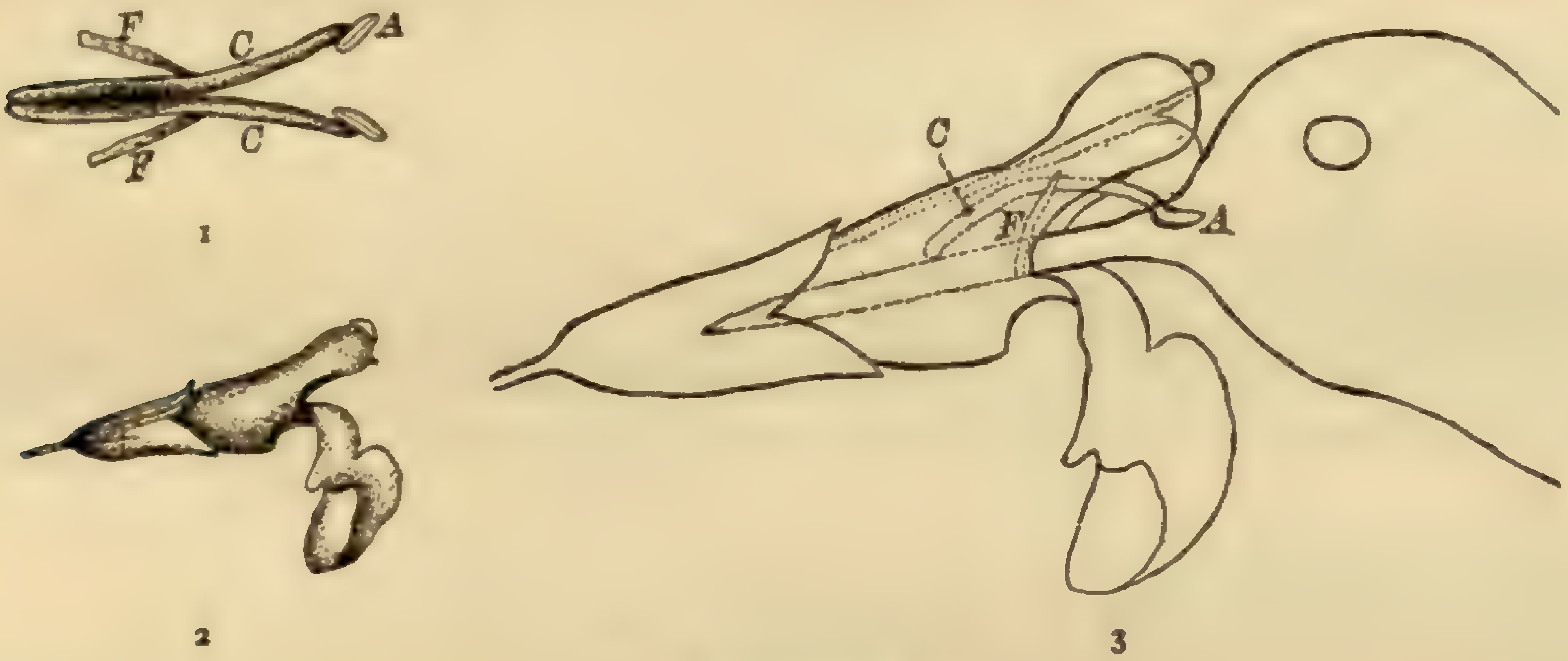
An examination of blossoms showed them to have the following described structure. The green striated calyx and scarlet labiate corolla are not striking. The pistil is bifurcate, the points protruding from the upper corolla lobe. The upper point is greatly recurved, the other slightly curved forward and downward. The stamens, two in number, are of an odd form, well known, however, to those familiar with this genus.

Their filaments are adherent to the corolla to within a short distance of its mouth, where they become free and run obliquely upward and forward, terminating on either side, close beneath the base of the upper lip. The connective is prolonged in each stamen into a slender longitudinally placed rod. Each connective is attached at its middle by a hinge joint to the end of its filament, thus forming an oblique lever with equal arms. The connectives are united for half their length. The anther-bearing ends are free, forming a Y-shaped affair with the arms close together (Fig. 3).

Experiments with a hummer skin and a salvia blossom demonstrate the method of fertilization. The posterior end of the lever is raised by the bird's bill, lowering the divided, anther-bearing end, one branch of which brushes each side of the bird's head, leaving its pollen among the feathers (Fig. 2). The sharp-pointed lower fork of the pistil in turn removes some of the pollen as the bird withdraws its bill. This may

come from its own anthers, or the anthers of another blossom. In dozens of flowers examined the pistil held pollen grains on its recurved tip.

It seems quite improbable that any of the bees or butterflies could force an entrance to this flower, while its scarlet color indicates that it does not bid for help from the night flying Lepidoptera. Several blossoms were found in which there was a small puncture at the base of corolla tube. These were at first attributed to bees, but as I later found a lepidopterous



Salvia Coccinea Linn.

1. Blossoms, ⅔ natural size. 2. Enlarged optical section, showing connectives raised by birds' bill and pollen being deposited on the feathers. 3. Free ends of filaments, connectives and anthers; enlarged. *A*, anthers; *C*, connectives; *F*, free portion of filaments.

larva in the act of making one of these holes, I now doubt if the bees use the trick with this salvia.

In the humming birds we have an agent fitted at once for tripping the stamen lever and carrying a load of pollen. Anna's Hummer has a bill .68 inch long, while a smaller species found here, *Selasphorus rufus*, has an exposed culmen .64 inch in length. These easily reach the bottom of the salvia corolla tube, which is .52 inch from base to mouth.

Dr. William Trelease has described a similar fertilization of *Salvia splendens* Sellow by the Ruby-throated Hummer (*Trochilus colubris*), *American Naturalist*, April, 1881. Dr. Trelease thus describes the life of an individual blossom:

"The life of a given flower may be divided into three periods: in the first, the anthers only being mature, it is staminate in function; in the second, some pollen remaining in the anthers,

while the stigmas become receptive, it is functionally hermaphrodite or perfect; and in the third, the pollen having been entirely removed, while the stigma, if unfertilized, retains its freshness, it is pistillate only so far as function is concerned" (*loc. cit.*, p. 266).

Professor W. C. Dudley kindly identified the present species for me as *Salvia coccinea* Linn.

SYNOPSES OF NORTH-AMERICAN INVERTEBRATES.

VI. The Astacidæ of North America.

W. P. HAY.

The following synopsis of the genera Astacus and Cambarus will be found to include all the valid species reported from the whole continent of North America.

The crayfishes, our largest and most conspicuous fresh-water crustaceans, are well known to every student of animal morphology. They occur in abundance in most lakes and streams, and, with the exception of the New England States and the Great Plains region, most localities will be found to support several species. They are especially abundant, individually and as species, in the southern and central portions of the United States.

In form, size, armature, color, and habits there is the greatest variation among the seventy-nine species and subspecies now recognized in the genus Cambarus and the five known species of Astacus. Moreover, almost every species is liable to show the most perplexing variations beyond those depending upon age and sex. On this account the identification of many species becomes exceedingly difficult, and in some cases is possible only when a set of type specimens is at hand. It is thought, however, that a careful use of the synopses given will enable even a beginner to identify with accuracy all but the most puzzling species. In the first list the natural groups are given with the characters distinguishing them, and the geographical distribution of each species is roughly indicated. The second list is a purely artificial key, based upon trenchant characters, by which any specimen, male or female, may be identified.

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LIST OF SPECIES WITH DISTRIBUTION.

ASTACUS,

Distribution limited to the Pacific watershed.

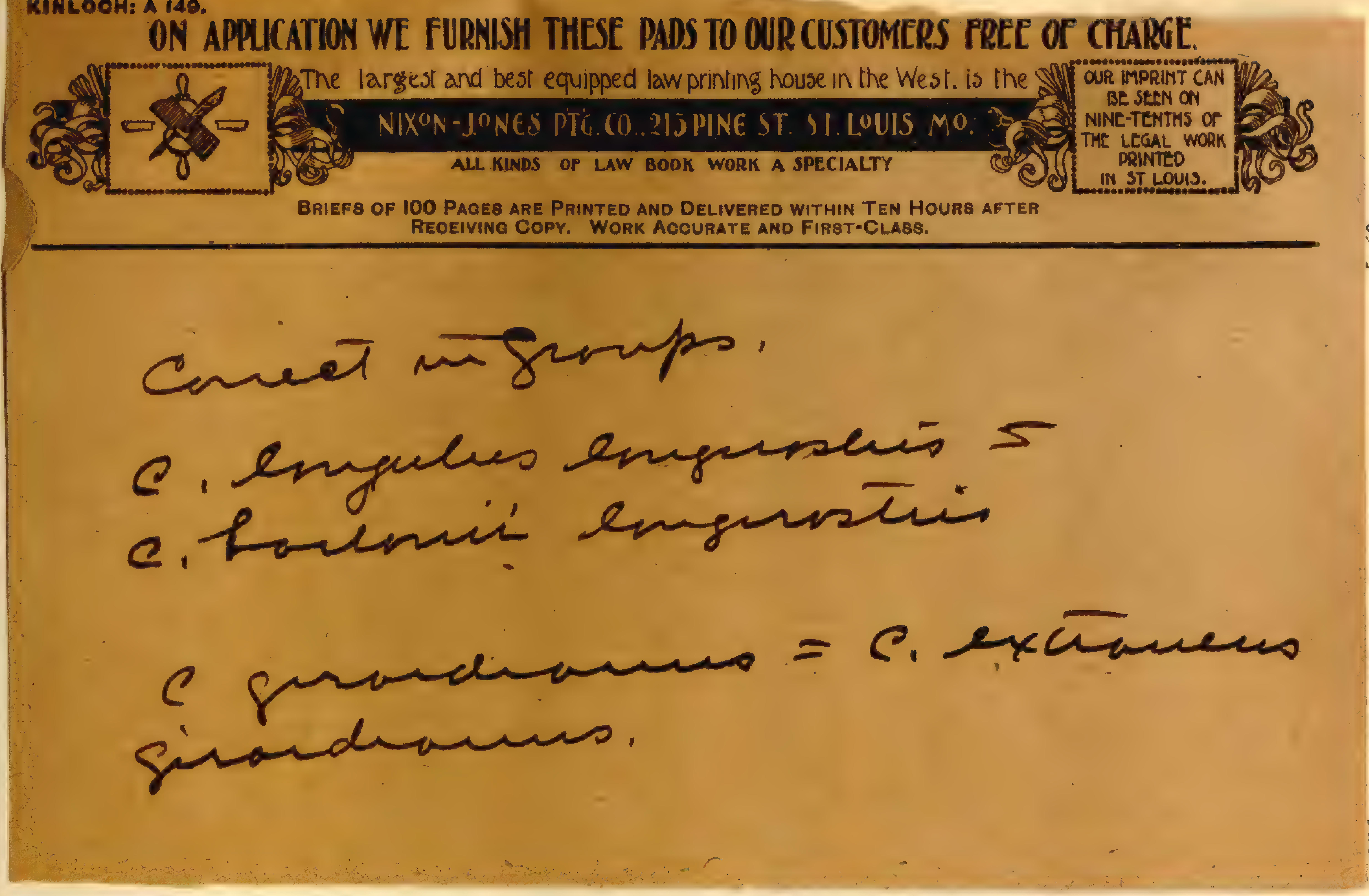
A. gambelli, Utah, Idaho, Montana.

A. nigrescens, San Francisco to Alaska (near coast).

A. leniusculus, Columbia R.

A. trowbridgii, Columbia R.

A. klamathensis, region about Klamath R. and L.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C. singulus angustus 5
C. forbesii angustatus
C girardianus = C. extraneus
girardianus.

CAMBARUS,

Distribution limited to Atlantic watershed except in Mexico.

The following natural groups of the crayfishes of Eastern North America are recognized:

1 First pair of abdominal appendages of the male clavate; the outer part truncate at the tip and provided with one to three curved teeth; the inner part terminated by a short acute curved spine.

Third segment of third and fourth pairs of legs of males hooked. ("Group I" of Faxon)

C. blandingii, N. Y. to Ala.
C. blandingii acutus, Ala., Tex., Ind.
C. fallax, Fla.
C. hayi, Miss.
C. clarkii, Tex. to Fla.
C. troglodytes, Ga. to S. Car.
C. lecontei, Ala., Ga.
C. angustatus, Ga.
C. pubescens, Ga.
C. spiculifer, Ga.
C. versutus, Ala., Fla.
C. alleni, Fla.
C. evermanni, Fla.
C. barbatus, Ga.
C. wiegmanni, Mex.
C. pellucidus, Ind., Ky. (Caves).
C. pellucidus testii, Ind. (Caves).
C. acherontis, Fla. (Caves).

Third segment of third pair of legs of males hooked. ("Group II" of Faxon)

C. simulans, Tex., Kan.
C. mexicanus, Mex.
C. advena, S. Ga.
C. gracilis, Ind., Ill., Mo. (?).
C. carinatus, Mex.
* *C. cubensis*, Cuba.
C. carolinus, S. Car., Tex.
(?) *C. clypeatus*, S. Miss.

2 First pair of abdominal appendages of the male terminated with two falcate teeth, the larger of which belongs to the outer part of the appendage, the smaller to the inner part. Third segment of third pair of legs of males hooked. ("Group III" of Faxon)

C. bartonii, N. B., Mo., N. C., Tenn.
C. bartonii robustus, Dom. Can., Ill.
C. longulus, Va., N. C., Tenn.
** *C. longulus longirostris*, Va., Ala., Tenn.
C. dubius, W. Va., Tenn.
C. uhleri, Md. ("eastern shore")
C. latimanus, S. C., Tenn., Miss.
C. acuminatus, S. C., N. C.
C. girardianus, N. Ala.
C. extraneus, N. Ga.
C. jordani, N. Ga.
C. argillicola, Dom. Can., N. C., La.
C. diogenes, N. J., Wy., Miss.
C. diogenes ludovicianus, La.
C. cornutus, Ky.
C. hamulatus, Nickajack Cave.
C. setosus, Caves in S. W. Mo.

* *C. cubensis = C. consobrinus* Sauss.
** = *C. bartonii longirostris* Fax.

3 First pair of abdominal appendages of the males furciform, terminating in two elongated nearly straight, acute tips. Third segment of third pair of legs of males hooked. ("Group IV" of Faxon)

C. lancifer, Miss., Ark.
C. affinis, S. N. Y., Va., L. Superior.
C. indianensis, S. Ind.
C. sloanii, S. Ind., Ky.
C. propinquus, Dom. Can., Minn.
C. propinquus obscurus, N. Y., Pa.
C. propinquus sanbornii, Ky., Ohio.
C. neglectus, Kan., Mo.
C. harrisonii, Mo.
C. virilis, Dom. Can., Tex., Kan.
C. immunis, N. Y., Wy., Tex.
C. immunis spinirostris, Tenn., Neb.
C. hylas, Mo.
C. pilosus, Kan.
C. nais, Kan.
C. mississippiensis, Miss.
C. palmeri, Tenn., Ind. Terr.
C. palmeri longimanus, Ind. Terr., Tex.
C. longidigitus, Ark.
C. difficilis, Ind. Terr., Ark.
C. meekii, Ark.
C. erichsonianus, Tenn., Ala.
C. alabamensis, N. Ala.
C. compressus, N. Ala.
C. medius, Mo.
C. rusticus, Pa., Ia., Tex.
C. spinosus, S. C., N. Ala.
C. putnami, Ky., Ind.
C. forceps, N. Ala., Va., Tenn.
C. digueti, Mex.

Third segment of second and third pairs of legs of males hooked. ("Group V" of Faxon)

C. montezumæ, Mex.
C. montezumæ dugesii, Mex.
C. montezumæ areolatus, Mex.
C. montezumæ occidentalis, Mex.
C. shufeldtii, La.
C. chapalanus, Mex.

Astacus.—Last thoracic somite bearing a gill on each side, thus making eighteen gills (plus two or three rudiments) in each branchial chamber. Orifice of green gland on posterior face of tubercle. First abdominal appendages of males neither toothed nor bifid at the apex and none of the thoracic legs with hooks. Annulus ventralis represented by a transverse ridge.

1 Margins of rostrum denticulate 2
1 Margins of rostrum smooth 3
2 Chelæ with a patch of soft setæ on outer face . . *A. gambelli* Gir.
2 Chelæ naked on outer face . . . . . *A. nigrescens* Stimp.
3 Postorbital ridges with a posterior spine or tubercle 4
3 Postorbital ridges without a posterior spine or tubercle *A. klamathensis* Stimp.
4 Acumen longer than distance between lateral teeth of rostrum *A. leniusculus* Dana
4 Acumen not longer than distance between lateral teeth of rostrum *A. trowbridgii* Stimp.

Cambarus. — Last thoracic segment without a gill, thus reducing the number in each branchial chamber to seventeen. Orifice of green gland at apex of tubercle. First abdominal appendages of males bifid and hooked or toothed at the apex. One or more pairs of thoracic legs of males with a hook-like tubercle on the third segment. In the females, annulus ventralis developed as a depressed cone on the sternum between the bases of the last pairs of legs.

1	Eyes normally developed	2
1	Eyes atrophied	84
2	Areola very narrow or obliterated	3
2	Areola of moderate or excessive width	18
3	Rostrum with lateral spines	4
3	Rostrum without lateral spines	11
4	Rostrum excessively lengthened, the posterior portion of carapace one-third as long as anterior	*C. lancifer* Hag.
4	Rostrum not excessively lengthened, posterior portion of carapace more than one-third as long as anterior	5
5	Rostrum with a low median longitudinal carina	*C. palmeri* Fax.
5	Rostrum without a carina	6
6	Sides of carapace coarsely granulate; inner finger of chelæ markedly sinuate	81
6	Sides of carapace slightly granulate or smooth	7
7	Areola obliterated for at least a portion of its length	8
7	Areola not obliterated at any point	9
8	First abdominal appendages of males with slender, nearly straight, acute tips. Annulus ventralis of females with a pronounced central fossa	*C. palmeri longimanus* Fax.
8	First abdominal appendages of males with short recurved tips. Annulus ventralis of females with the central fossa almost obliterated	*C. difficilis* Fax.
9	Lateral teeth of rostrum small	*C. nais* Fax.
9	Lateral teeth of rostrum strong	10
10	Anterior border of carapace angulated below the eye	*C. longidigitus* Fax.
10	Anterior border of carapace not angulated	*C. pilosus* Hay
11	Base of rostrum not foveolate	*C. advena* LeC.
11	Base of rostrum with a more or less pronounced foveola	12
12	Anterior border of carapace angulated below the eye	13
12	Anterior border of carapace not angulated below the eye	15
13	Areola linear but not obliterated	*C. gracilis* Bun.
13	Areola obliterated in the middle	14
14	Sides of rostrum straight	*C. diogenes* Gir.

14 Sides of rostrum concave . . *C. diogenes ludovicianus* Fax.

15 Areola linear but not obliterated 16

15 Areola obliterated in the middle 17

16 Rostrum short, slightly longer than broad . *C. carolinus* Erich.

16 Rostrum twice as long as broad . . *C. mississippiensis* Fax.

17 Upper surface of rostrum plane and faintly carinate *C. uhleri* Fax.

17 Upper surface of rostrum excavated, not carinate *C. argillicola* Fax.

18 Rostrum with lateral teeth 19

18 Rostrum without lateral teeth 63

19 Sides of carapace with two spines just behind the cervical groove . 20

19 Sides of carapace with only one spine or unarmed 21

20 Proximal segment of telson with three or four spines on each side of the posterior border . . . . . . *C. versutus* Hag.

20 Proximal segment of telson with only two spines *C. spiculifer* LeC.

21 Rostrum with a more or less pronounced median longitudinal carina above 22

21 Rostrum without a carina 29

22 Proximal segment of telson with three spines on each side *C. carinatus* Fax.

22 Proximal segment of telson with only two spines on each side . . 23

23 Sides of carapace with a spine 24

23 Sides of carapace unarmed . . . . *C. compressus* Fax.

24 Outer finger of chela bearded at base on inner margin . . . 25

24 Outer finger of chela not bearded 26

25 Rostrum slightly excavated, carina broad, low, and rounded *C. alabamensis* Fax.

25 Rostrum deeply excavated, carina very faint . . *C. meeki* Fax.

26 Rostrum slightly excavated (broad and nearly plane above) *C. neglectus* Fax.

26 Rostrum well excavated (narrower and deeply grooved) . . . 27

27 Postorbital spine strong . . . . . . *C. meeki* Fax.

27 Postorbital spine weak 28

28 Rostrum with a low carina . . . . . *C. propinquus* Gir.

28 Rostrum with a high, sharp carina . . . . *C. digueti* Bouv.

29 Flagellum of antenna excessively flattened and heavily ciliate along the inner margin . . . . *C. cornutus* Fax.

29 Flagellum of antenna normal 30

30 Carapace without lateral spines 31

30 Carapace with lateral spines 39

31 Sides of rostrum straight or concave 32

31 Sides of rostrum convex 34

32 Postorbital spines small or wanting . . . . *C. virilis* Hag.

32 Postorbital spines well developed 33

33 Areola broader . . . . *C. rusticus* Gir.

33 Areola narrower . . . . *C. meeki* Fax.

34 Postorbital spines wanting 35

34 Postorbital spines present 36

35 Sides of rostrum converging uniformly to the apex, no acumen *C. montezumæ occidentalis* Fax.

35 Sides of rostrum angulated or slightly toothed near the apex, thus defining an acumen . . . . . . *C. montezumæ* Sauss.

36 Rostrum long and slender, with stout, sharp lateral spines and slender acumen ; postorbital spines strong . . *C. chapalanus* Fax.

36 Rostrum of medium length, with small lateral teeth and short, broad acumen ; postorbital spines small 37

37 Sides of rostrum raised as sharp ridges . *C. montezumæ dugesii* Fax.

37 Sides of rostrum not raised as sharp ridges 38

38 Branchiostegal spine not developed *C. montezumæ areolatus* Fax.

38 Branchiostegal spine developed but small . . *C. cubensis* Erich.

39 Posterior portion of carapace considerably less than half as long as anterior portion 40

39 Posterior portion of carapace half or nearly half as long as anterior portion 42

40 Areola wide 41

40 Areola rather narrow . . . . . . *C. lecontei* Hag.

41 Proximal segment of telson with three spines on each side *C. angustatus* LeC.

41 Proximal segment of telson with four spines on each side *C. pubescens* Fax.

42 Anterior border of carapace with a projecting angle below the eye . 43

42 Anterior border of carapace not angulated 54

43 Suborbital angle spinulose 82

43 Suborbital angle not spinulose 44

44 Rostrum nearly plane above 45

44 Rostrum well excavated 46

45 Acumen long . . . . *C. jordani* Fax.

45 Acumen rather short (size small) . . . . *C. shufeldtii* Fax.

46 Areola narrow 47

46 Areola of moderate or excessive width 48

47 Margins of rostrum concave . . . . . . *C. meeki* Fax.

47 Margins of rostrum slightly convex . *C. immunis spinirostris* Fax.

48 Areola wide . . . . *C. sloanii* Bun.

48 Areola of moderate width 49

49 Acumen of rostrum short 50

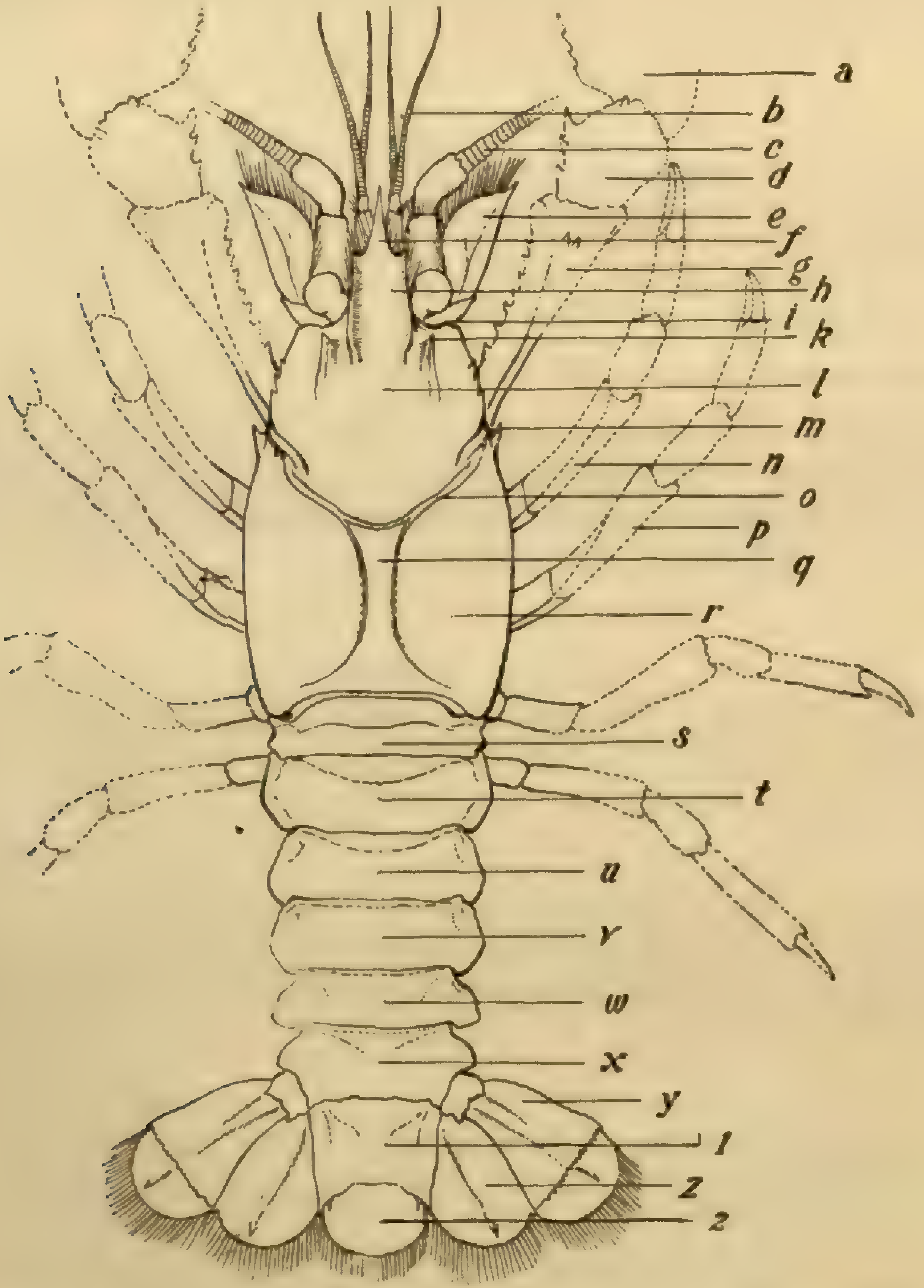
49 Acumen of rostrum not short 51

50 Lateral teeth of rostrum well developed but short, sides of rostrum nearly parallel . . . . *C. blandingii* Har.

50 Lateral teeth of rostrum poorly developed, sides of rostrum convergent *C. blandingii acutus* Gir.

51 Anterior portion of carapace a very little more than twice as long as anterior portion . . . . *C. spinosus* Bun.
51 Anterior portion of carapace not more than twice as long as posterior portion 52
52 Rostrum faintly carinate . . . . . . *C. forceps* Fax.
52 Rostrum not carinate 53
53 Acumen of moderate length . . . . . . *C. hylas* Fax.
53 Acumen long and slender . . . . . . *C. putnami* Fax.
54 Sides of rostrum concave 55
54 Sides of rostrum not concave 57
55 Lateral spines of carapace strong . . . . *C. indianensis* Hay
55 Lateral spines of carapace small or obsolete 56
56 Postorbital spines well developed . . . . *C. harrisonii* Fax.
56 Postorbital spines small or obsolete . . . *C. rusticus* Gir.
57 Lateral spines of carapace strong 58
57 Lateral spines of carapace small and weak 60
58 Sides of rostrum nearly parallel, acumen long and rather slender . 59
58 Sides of rostrum convergent, acumen short . . . *C. hayi* Fax.
59 Postorbital spines strong, sides spiny . . . *C. affinis* Say.
59 Postorbital spines small, sides not spiny . . *C. erichsonianus* Fax.
60 Proximal segment of telson with three or four spines on each side *C. fallax* Hag.
60 Proximal segment of telson with only two spines on each side . . 61
61 Rostrum deeply excavated . . *C. propinquus sanbornii* Fax.
61 Rostrum slightly excavated or subplane 62
62 Tip of acumen abruptly turned upward . . . *C. virilis* Hag.
62 Tip of acumen gently curved upward . . . *C. obscurus* Hag.
63 Carapace with one spine on each side just behind cervical groove . 64
63 Carapace without lateral spines 67
64 Postorbital and branchiostegal spines well developed . . . 65
64 Postorbital and branchiostegal spines small or wanting . . . 66
65 Areola narrow . . . . *C. wiegmanni* Erich.
65 Areola broad . . . . *C. acuminatus* Fax.
66 Base of rostrum slightly foveolate . . . . *C. immunis* Hag.
66 Base of rostrum not foveolate . . . . . *C. virilis* Hag.
67 Branchiostegal spine developed 68
67 Branchiostegal spine wanting 74
68 Anterior border of carapace decidedly angulated below the eye . 69
68 Anterior border of carapace hardly angulated 73
69 Proximal segment of telson with three or four spines on each side . 70
69 Proximal segment of telson with only two spines on each side . 71
70 Rostrum pubescent and nearly flat above . *C. mexicanus* Erich.
70 Rostrum not pubescent, deeply excavated . . *C. alleni* Fax.
71 Inner surface of hands with a more or less thick covering of soft setæ *C. barbatus* Fax.

71 Inner surface of hands not setose 72
72 Cervical groove broken on the sides . . . *C. virilis* Hag.
72 Cervical groove not broken on the sides . . *C. latimanus* Erich.
73 Areola carinate . . . . *C. simulans* Fax.
73 Areola not carinate 83



Outline drawing of Cambarus affinis ♂ showing most of the structures mentioned in the diagnosis of the species of crayfishes. *a*, chela; *b*, 1st antenna (antennules); *c*, 2d antenna (antenna); *d*, carpus (of chelaped); *e*, antennal scale; *f*, acumen (of rostrum); *g*, meros (of chelaped); *h*, rostrum; *i*, suborbital angle; *k*, postorbital spine and ridge; *l*, anterior (gastric) portion of carapace; *m*, lateral spine (of carapace); *n*, second pair of legs; *o*, cervical groove; *p*, third pair of legs; *q*, areola; *r*, posterior (branchio-cardiac) portion of carapace; *s*, *t*, *u*, *v*, *w*, *x*, segments of abdomen; *y*, *z*, outer and inner blades of caudal fin; *1*, *2*, proximal and distal segments of telson.

74 Rostrum with a longitudinal median carina above . *C. medius* Fax.
74 Rostrum not carinate 75
75 Rostrum deeply excavated 76
75 Rostrum not deeply excavated 77
76 Rostrum strongly decurved, areola narrow . . *C. dubius* Fax.

76 Rostrum not strongly decurved, areola not narrow . *C. virilis* Hag.
77 Rostrum long, antennal scale long and broad . *C. montezumæ* Sauss.
77 Rostrum short, antennal scale short and narrow 78
78 Edges of rostrum swollen and raised, fingers gaping widely at base, outer finger more or less bearded within at base. . . . 79
78 Edges of rostrum not swollen, fingers not widely gaping at base, outer finger not bearded 80
79 Spines of postorbital ridges weak; suborbital angle not produced *C. longulus* Gir.
79 Spines of postorbital ridges strong; suborbital angle produced, almost spiniform . . . . *C. longulus longirostris* Fax.
80 Carapace depressed, sides gently curving toward front and rear; hands not impressed . . . . *C. bartonii* Fab.
80 Carapace cylindrical, sides nearly parallel as far forward as cervical groove, then curving abruptly to base of rostrum. Hands strongly impressed . . . . *C. bartonii robustus* Gir.
81 Rostrum of medium length, well excavated, lateral teeth strong *C. clarkii* Gir.
81 Rostrum short, almost flat above, lateral teeth small *C. troglodytes* LeC.
82 Distal end of meros with one small spine on superior surface *C. girardianus* Fax.
82 Distal end of meros with two strong spines on superior surface *C. extraneus* Hag.
83 Proximal segment of telson with two spines on each side *C. evermanni* Fax.
83 Proximal segment of telson with four or more spines on each side *C. clypeatus* Hag.
84 Areola broad and long, with parallel sides; carapace nearly smooth, very lightly granulate on the sides 85
84 Areola narrow, with curved sides; carapace roughly granulate on the sides at least 87
85 Rostrum foveolate at base . . *C. hamulatus* Cope and Pack.
85 Rostrum not foveolate 86
86 Sides of carapace spiny . . . . . *C. pellucidus* Tellk.
86 Sides of carapace unarmed . . . . *C. pellucidus testii* Hay
87 Sides of carapace granulate and setose; no lateral or postorbital spines; areola very narrow . . . . *C. setosus* Fax.
87 Sides of carapace tuberculate; lateral and postorbital spines developed; areola linear . . . . . . *C. acherontis* Lönn.

REVIEWS OF RECENT LITERATURE.

GENERAL BIOLOGY.

A Rational Vitalism. — A most significant feature of the biological thought of to-day is the effort to place upon a solid foundation the idea of elementary vitalistic phenomena as thinkable processes, which are independent of all known chemical and physical forces and as worthy of scientific recognition and as capable of exact statement as is gravitation or chemical affinity.

Driesch in a recent paper[1] seeks to furnish a proof of the existence of vitalistic phenomena of an elementary character, not by bringing forward new facts, but by the interpretation of already published observations in the domain of experimental morphology. It should be at once mentioned that, whereas Driesch combats strongly the absolute dominance of the mechanical theory of life processes, as confusing that which is merely understandable with that which is actual and capable of proof, and so as becoming dogmatic and misleading, he clearly discountenances the older uncritical vitalism with its implied supernatural teleology and its absence of all well-defined relation to the fundamental ideas of causality, energy, matter, etc.

The author looks to the problem of localization of morphogenetic processes as the divining rod by the aid of which we may be led into this new land of promise. Why is it that the archenteron of the well-developed gastrula of Sphærechinus becomes constricted in two places, thus marking off from one another the stomadæum, mesenteron, and proctodæum? Moreover, why do similar constrictions occur in the archenterons of each of the two half embryos, which result from the dividing in the equatorial plane of a well-developed gastrula in such wise that each half contains its share of the endoderm as well as of ectoderm? The wound heals, and the constrictions occur in each embryo at the same proportionate distances from the poles of the embryo as in the normal larva. The cause of this phenomenon, and of others similar to it, is not to be found,

[1] Driesch, H. *Die Localisation morphogenetischer Vorgänge: Ein Beweis vitalistischen Geschehens.* Leipzig, 1899. 82 pp. Published also in *Archiv für Entwicklungsmechanik*, etc., Bd. viii, 1, pp. 35–111, 1899.

according to the author, in any known chemical or physical force, but in an hypothetical *Fernkraft*, an elementary vital force which acts at definite distances from fixed points, like the active pole of the egg, or from the median-ventral line of the bilaterally symmetrical embryo, to determine in some definite manner the form.

Various localization problems of a special nature are discussed. Treating of cleavage among the echinoderms, the author deduces from his own and others' experiments upon the segmentation of egg fragments and of isolated blastomeres, the displacement of blastomeres, etc., the conclusion that the protoplasm of the egg, in general, depends upon a certain factor, inherent in the protoplasm, upon which the cleavage and a general regulation of the egg mass depend, and he also asserts as proved the proposition that all parts of the cytoplasm during segmentation are respectively similar as regards their morphological "prospective potency," and that the nuclei are likewise similar each to each. From this standpoint he reasons that the earliest differentiation of the embryo is determined as to its position by a correlating force, this conclusion being quite opposed to the idea that the protoplasm of the egg consists of manifold elements arranged in some sort of a typical specific position, which bears a certain definite relation to later differentiation. If then the structure of the egg consists, as is assumed, merely of a polarity, namely the possession of a chief axis with unlike poles and one at right angles to it which also has unlike poles, how can one explain the localization of a variety of structures in the embryo not only at the poles but at any possible, though typical, position in the embryo? Likewise the arrangement of the bilateral groups of mesenchyme in the echinoids in definite typical positions, the appearance of the mouth in its proper place, independently of any possible contact stimulus proceeding from the archenteron, the localization of the ciliated band of Bipinnaria, all are problems of localization of a similar nature.

The eggs of ctenophores and of mollusks naturally present certain difficulties, since in them no regulation of the entire egg mass is proved and a definite complex structure of formative materials within the ovum is conceivable. Nevertheless the author believes that the power is there, though dormant, and that a sort of precocious activity of the localizing force may explain the difference between these eggs and those of the echinoderms, Amphioxus, etc. Moreover, if a complicated structure is assumed for the ovum of the ctenophore or of the mollusk, then the very structure of such typical complex nature presupposes in oögenesis a localizing agency.

Another well-marked case in which this same phenomenon is manifest is the "reparation" of Tubularia. How is it that the two circlets of buds of the new hydranth arise not on the surface of the wound of the transsected hydrocaulus, but always at a definite distance from that surface?

Finally, the results of Morgan's experiments upon regeneration in Planaria, which show that each of the several pieces cut from one individual becomes transformed by a shifting and differentiation of the protoplasm into a small and typically proportioned worm, likewise demand for an interpretation some controlling factor with localizing power.

In a discussion of the idea of localization in general, it is shown that the phenomenon of determination of position of parts may or may not require for its explanation the postulate of a localizing force of an elementary kind. In many instances of localization phenomena among plants, as in the transformation of indifferent leaf germs into foliage leaves or bud scales by the influence or absence of light, the localizing power consists in the direct action of a definite external stimulus upon parts which possess equal, though restricted, possibilities. In such cases as this, and in ordinary regeneration among animals, like the restoration of an amputated leg in Triton, localization is determined by the nature and position of the external stimulus (light, heat, etc.) or by the limited "potency" of the parts. Therefore no localizing action of an elementary nature occurs in these instances.

It is shown that the localization phenomena which are independent of specific external stimuli and of a simple elementary nature are confined to that association of cells or elementary structures of whatever kind which Driesch terms a harmonic equipotential system. In an equipotential system, in general, every part has an equal "prospective potency" with every other, *i.e.*, equal power as to the possibilities of its development. The willow twig, for example, is an equipotential system in which every part has indeed an equal prospective potency with every other; but here the power is limited to the production of sprouts and roots that are indefinite in number and have no specific relation to one another. An equipotential system which is thus restricted in its possibilities is called a determined equipotential system. In the segmenting egg of an echinoid or in the stem of Tubularia, however, every "effect" appears only once or a limited number of times, and stands in a definite relation to all other "effects." Such are accordingly called harmonic equipotential

systems, and it is the phenomena of localization which occur in such systems that require an elementary vitalistic force for their explanation. An organization as regards primary axial relations, which is present at the beginning of development, is considered to be an essential part of the conditions of every harmonic equipotential system, and it is therewith an essential presupposition of its differentiation. Moreover, the activities which occur in such a system as the result of some disturbance of the course of development indicate the existence of a regulatory power, which is a fundamental character that is intimately associated with the localization of differentiation.

In defining formally the localizing action which takes place in harmonic equipotential systems, Driesch makes first a statement in terms of cause and effect. Thus we may suppose one of the terminal points of the axis of any structure under consideration to be the seat of forces which act at a distance. This place may be said to exert an influence, to which that part upon which it works must be able to respond. Reverting to the constriction of the archenteron of the gastrula of echinoderms, the author claims that the cause of the constrictions lies in the "potency" of the system; the *Fernkraft*, acting through a definite typical distance, determines where the constrictions shall be. The distance, however, is not absolute, but proportionate to the size of the system. As the system becomes modified and more complicated, new points of reference are formed, from which still other sorts of *Fernkraft* act. If the formation of the mouth of the larva of echinoids be taken as another example, the force in question is presumed to operate from the anterior and posterior poles, and at a certain proportionate distance between them; its localization in the median ventral line depends upon the primary bilateral orientation of the whole embryo, which results in the taking on of a unique and special character by that line. The writer shows furthermore that this localizing force may act not only upon the surface of a sphere or other curved surface, but also upon the area between two concentric spheres, etc.

In treating of the relations of the effect (*viz.*, the action of localization) to the cause (the postulated force), Driesch shows that conditions obtain which are very different from those of purely physical or chemical transformations, for the cause is neither transferred quantitatively to the effect, as in mechanical and physical action, nor does it reappear in the effect as a product of the reaction, as in chemical transformations. In the case at hand every specific cause (acting in reference to quantity, *i.e.*, distance) has a corresponding

effect in localization, making possible the attainment of a given end. Such a process Driesch calls undetermined adaptive action or a phenomenon of response.

The author furthermore seeks a functional representation of the events which occur when the course of development is disturbed by an experiment and in which localization phenomena are, of course, implied. That which happens is found to be a function of (1) the final condition (toward which normal development proceeds) and of the condition of the embryo immediately (2) before and (3) after the disturbing act; and, since the third factor is a variable, the process as a whole is of a variable nature. A certain "teleology" is implied in these events and in all ontogenetic processes in that they are the means toward specific ends. Thus the events which follow any disturbance of development are characterized as being dependent upon the final condition. The regulatory phenomena which attend disturbances of mechanical systems, on the other hand, are of a quite different nature, since they are independent of any final condition and depend wholly upon factors that are constant.

Finally, the action of localization is found to be dependent upon the absolute size of the system (G), upon the local relations that exist in the complete absolute-normal system (R), and on the primary orientation in reference to a definite system of coördinates. If the last factor is assumed to be known, then xyz (the place) $= \phi \, [G.R]$. This formula is found not to be applicable to inorganic bodies, since in them the localization of specific details of structure is determined by the direct action of external forces without reference at all to the absolute size of the system.

Enough has been shown of Driesch's excellent discussion of these difficult problems of localization to enable the reader to foresee the final conclusion of the author: Since there exists in the processes of ontogenetic differentiation this group of phenomena which are not subordinate to any known laws of inorganic matter, but which make it necessary to assume a special definite elementary action in accordance with fixed laws, it may be regarded as proved that Vitalism, *i.e.*, that conception which sees in life processes events with elementary laws which are peculiar to organic beings, now stands upon a firm foundation.

After a careful study of this important paper the reader will perhaps feel the insufficiency of the postulated localizing *Fernkräft* in itself. Of all that is implied in the "potency" of a "harmonic equipotential system," he would know more. A lingering doubt perhaps

remains in the reader's mind as to whether a fuller knowledge of the "potency" might make the supposition of the *Fernkraft* unnecessary. Cannot formative material operated by chemical and physical forces yet furnish a solution of the problem? Before one is quite converted from the dogmatic materialism of the day to the rational vitalism of Driesch, it is fitting to know well the grounds of the new belief. The phenomena of localization are most admirably analyzed and discussed in the paper under consideration. Other general questions therein implied, as, for instance, Prospective Potency, are ere long to receive, we are informed, a fuller definition and discussion. These further studies will be awaited with much interest.

John H. Gerould.

Praxis und Theorie der Zellen- und Befruchtungslehre.[1] — This is a book of 260 pages, with 137 text-figures, and is designed to be a practical guide for courses in cytology. As such it cannot fail to be of service, since it is the first work yet published with this distinctive aim. There is, to be sure, in Bergh's *Zelle und Gewebe* an appendix on technique, but this is no more extensive than may be found in many text-books of histology, while the larger works of Hertwig, Wilson, and Henneguy present the facts and theories with regard to the cell from a general rather than from a laboratory standpoint.

As the title indicates, the book also presents in brief form the general facts and theories of cytology, together with a short historical review of different phases of the subject and references to some of the more important literature. This feature of the work, however, lacks the completeness and critical character of the larger works devoted to this field, while the laboratory directions are so interwoven with the general part as to make the book much less readable than the other works mentioned. Unfortunately this combination also renders the book less useful as a laboratory guide, since the directions for preparing and observing material are less concise and explicit, and are much more difficult to find than would otherwise be the case.

The book is the outgrowth of a practical course on the cell given at the Zoölogical Institute at Freiburg, and in conformity with this course the contents are divided into sixteen days, two or three objects being considered each day. The subject for each day and the objects of study are as follows: First Day, Plant and animal

[1] Hacker, Dr. Valentin. Jena, Gustav Fischer, 1899, 7 marks.

tissue cells: Objects, stamen hairs of Tradescantia, epidermis of larval salamander. Second Day, Unicellular organisms: Objects, Amœba, Pelomyxa, Stylonichia. Third Day, Resting nuclei; nuclear reticulum and nucleoli: Objects, living nuclei from the urinary bladder of Salamandra, ovarian eggs of Siredon and Triton. Fourth Day, Chemistry of the cell nucleus: Objects, sperm of salmon and trout, leaf epidermis of Leucojum. Fifth Day, Physiology of the cell nucleus: Objects, Stentor, root hairs of seedlings of pea, egg tubes of Dytiscus. Sixth Day, Cell division, (*a*) Chromatic Figure: Objects, epithelium from cornea and tail of larval salamander, peripheral protoplasmic layer of the embryo sac of Fritillaria, testis of salamander. Seventh Day, Cell division, (*b*) Achromatic Figure: Fertilized eggs of Ascaris, uterine eggs of Thysanozoön. Eighth Day, Centrosomes: Objects, eggs of Cyclops, pigment cells of the corium of the pike, winter eggs of Sida. Ninth Day, Oögenesis, (*a*) Germinal Vesicle: Objects, ovary of Canthocamptus and of other fresh-water copepods. Tenth Day, Oögenesis, (*b*) Germinal Spot and Yolk Nucleus: Objects, ovarian eggs of fresh-water mussel, fertilized eggs of Myzostoma, ovarian eggs of Tegnaria and Pholcus. Eleventh Day, Oögenesis, (*c*) Polar-body Formation: Objects, fertilized eggs of starfish, uterine eggs of Ascaris. Twelfth Day, Spermatogenesis: Objects, sperm tubes of Ascaris, testis of salamander. Thirteenth Day, Reduction divisions: Objects, oviducal eggs of Diaptomus, uterine eggs of Thysanozoön, laid eggs of Cyclops. Fourteenth Day, Fertilization of the metazoön egg: Objects, living eggs of Diplogaster and Rhabditis, eggs of sea urchin, uterine eggs of Ascaris. Fifteenth Day, Fertilization, further facts and theories: Objects, bastard larvæ of sea urchin, Antherozoids of the Fern, bastard larvæ of Echinus and Sphærechinus (including Boveri's famous experiment on the fertilization of enucleated eggs), results of crossing white mice with the Japanese house mice. Sixteenth Day, Cells of the germ tracks: Objects, uterine eggs of Ascaris, eggs of *Cyclops brevicornis*.

The subjects considered show that the field is well covered, while the objects taken up for study on some of the days would indicate that the "day" is to be interpreted in the Biblical sense. The most notable omission from the practical work is the whole subject of the cleavage of the egg, in which are illustrated, as perhaps nowhere else, the various kinds of cell division (equal, unequal, differential, etc.), the mechanics of cell division, experimental modifications of cleavage, and the promorphology of the ovum. These subjects are briefly

discussed under the fertilization of the egg, but no practical work is suggested. Some of the objects suggested for study are not of sufficiently wide or abundant occurrence to make them generally accessible, *e.g.*, the eggs of Thysanozoön, Sida, Myzostoma, Siredon, and the repetition of Boveri's experiment on the fertilization of enucleated egg fragments. In spite of these limitations, the work will be of great value to all who are giving courses on practical cytology.

Davenport's Statistical Methods.[1] — This work is intended to meet "the call for a simple presentation of the newer statistical methods in their application to biology," and seems an admirable handbook for the purpose. It consists of definitions and explanations of methods, including "the seriation and plotting of data and the frequency of the polygon," etc., with a selected bibliography of the subject, the whole occupying less than fifty pages, followed by about one hundred pages of formulas and logarithmic tables. Chapter V (pp. 38, 39) gives "Some Applications of Statistical Biological Study." While the "newer statistical methods" are admirably suited to the investigation of certain special problems, which may be of the highest interest and importance, they seem too minute and detailed, and to require the expenditure of too much time and labor, to be of very broad application, such as the author apparently contemplates. Thus, it is said: "The origin of species through geographical segregation can be studied by the determination of *place-modes;* that is, the modal condition of specific characters of one and the same species in various localities. The progress of specific differentiation will be measured by the change in place-modes from decade to decade, or by the formation of a binomial curve in the place of a modal one; by the gradual separation of the two modes of a binomial curve." Theoretically this is possible, but taking into account what it implies, even for a single species, does it not border on the chimerical, or at least on the impracticable? First is necessarily involved a geographical area of considerable extent — at least hundreds of miles square, under ordinary conditions of topography — within which many observation stations must be chosen, and at which work must be continued "from decade to decade," and detailed measurements made of every measurable feature of many

[1] *Statistical Methods* with special reference to Biological Variation. By C. B. Davenport, Ph.D., Instructor in Zoölogy at Harvard University. First edition. First thousand. New York, John Wiley & Sons. London, Chapman & Hall, Limited, 1899. — 12mo, 148 pp.

thousands of individuals. And this not only for one species but for a whole fauna, as: "A basis for an arbitrary *distinction between species and varieties* may be gained by determining a degree of divergence and of isolation which shall be used to distinguish the two. A degree of divergence of thrice the standard deviation has been suggested as a convenient line between species and varieties." The idea of such a broad application of the "newer statistical methods," and for such purposes, seems at present Utopian, because simply impracticable. Again, an arbitrary standard of deviation which may be perfectly legitimate for one group, as a genus or family, would prove inapplicable for another group of similar grade within even the same class.

As already said, the scheme is theoretically admirable, and is no doubt applicable to many special problems, but is too costly in time, material, and labor to be of the wide or general applicability in determining species and subspecies, or the methods and causes in the segregation of geographic forms, apparently contemplated by the author of the present manual. The gross methods already in vogue, being tolerably efficient for temporary and tentative purposes, will probably hold the field for a while at least, so that it will be in the remote future when, through the plotting of curves and the use of logarithmic tables, we shall see "by the use of the quantitative method biology . . . pass from the field of the speculative sciences to that of the exact sciences" (p. 39).

J. A. A.

The question of the former existence of an Antarctic continent with a flora and fauna of its own, the remnants of which are still recognizable in the southern continents, has been brought into prominence recently, and we should like, in this connection, to call attention to a paper published in Australia that, although issued four years ago, has not been noticed sufficiently in other countries. C. Hedley[1] starts from the fact mentioned already by early travelers, that Tasmania, Australia, New Zealand, South America, and partly also South Africa contain certain forms of life in common which are not represented elsewhere, and concludes that this community of type cannot be explained but by community of origin, and that we have to look for a connection of these now separated parts by former land bridges.

After discussing and criticising the theory of Hutton, which con-

[1] Hedley, C. Considerations on the Surviving Refugees in Austral Lands of Ancient Antarctic Life, *Roy. Soc. N. S. Wales*. Aug. 7, 1895.

structs this bridge across the South Pacific from Chile to Samoa and thence to New Zealand, that of Forbes, which assumes an immense Antarctic continent, and that of Pilsbury and v. Ihering, which accounts for the similar forms in South America, Tasmania, and Australia by the hypothesis of a former more extensive Austral continent which subsequently became united with South America at Cape Horn, Hedley gives his own solution of the problem. He says that "during the Mesozoic or older Tertiary, a strip of land with a mild climate extended across the South Pole from Tasmania to Terra del Fuego, and that Tertiary New Zealand then reached sufficiently near to this Antarctic land, without joining it, to receive by flight or drift many plants and animals." This "Antarctica" was of an unstable character, "at one time dissolving into an archipelago, at another resolving itself into a continent." Thus a deep gulf extended from Tasmania to Cape Horn, stretching within a few degrees of the pole, and this assumption would tend to explain some facts of distribution of marine shallow-water animals.

It seems to us that this theory has some advantage over the other theories mentioned, yet it is perhaps premature to form a distinct idea as to the connection of the southern ends of the present continents. That such was present before or at the beginning of Tertiary times seems to be beyond doubt, but for the actual construction of this bridge the data at hand seem to be too imperfect. But this much we may safely assume, as Hedley does, that this bridge was no constant and solid mass all the time it existed, but was repeatedly broken up into parts, making possible an exchange of life in different directions.

The particular idea of Hedley on this subject, even if we do not at once accept it, is at least worth considering seriously, and the frequent and very complete references to previous writers form one of the features of his article that make it the more valuable for the student of this fascinating question of the "Antarctica." A. E. O.

ZOÖLOGY.

Accessory Bladders of Turtles. — F. W. Pickel[1] has studied the accessory bladders of turtles, and finds these organs present in semi-

[1] Pickel, F. W. The Accessory Bladders of the Testudinata, *Zoölogical Bulletin*, vol. ii, No. 6, pp. 291–301. September, 1899.

terrestrial and semi-aquatic species. They are wanting, or greatly reduced, in the strictly aquatic and strictly terrestrial forms. The author believes that these bladders are receptacles for liquid stored up for the use of the animal, but he could not confirm the statement of earlier observers that the fluid was water taken in through the cloaca.

G. H. P.

Osteology of the Percesoces. — Professor Edwin Chapin Starks, now of the University of Washington, gives in the *Proceedings of the United States National Museum*, pp. 1–10, a valuable study of the osteology of the suborder of fishes known as Percesoces. He finds the members of this group less closely related than would be supposed from their resemblance in external characters, although really allied. The Sphyrænidæ (Barracudas) stand as a group opposed to the remaining families Mugilidæ (mullets) and Atherinidæ (silversides: Pesce-Rey). The osteology of a typical member of each family is given, with illustrative plates by the skillful hand of Mrs. Starks, who, as Chloe Lesley, was formerly the artist of the Hopkins Laboratory at Stanford University.

In all these species the so-called coronoid bone is present, but Professor Starks doubts its homology with the coronoid bone of reptiles, and thinks that the systematists have made too much of it and the anatomists not enough. It has little systematic value, for it is present in many unrelated genera (catfish, sucker, striped bass, bluefish, cod), while, on the other hand, it has been generally overlooked by anatomists as a structure present in fishes.

Starks on the Relationships of Dinolestes. — In the *Proceedings of the United States National Museum*, Professor Edwin Chapin Starks undertakes to settle the vexed question of the affinities of the Australian fish, *Dinolestes lewini*, by a study of its osteology.

In spite of its resemblance to the Barracuda and the Pesce-Rey, he finds no evidence of close affinity and places Dinolestes among the true percoids. It is probably allied to Sphyrænops and Scombrops and belongs to the family of Cheilodipteridæ.

The Peripheral Nervous System of Bony Fishes. — The cranial and first spinal nerves of the common silverside, Menidia, have been investigated by C. J. Herrick.[1] Four components are now generally recognized in the spinal nerves of vertebrates: (1) somatic motor

[1] Herrick, C. J. The Peripheral Nervous System of the Bony Fishes, *Bull. U. S. Fish Comm., 1898.* pp. 315–320. 1899.

fibres derived from the ventral horn cells of the cord and distributed to the striated body musculature; (2) somatic sensory or general cutaneous fibres terminating in the dorsal horn and supplying the skin of the body; (3) visceral motor fibres supposed to pass from the lateral horn outward by both dorsal and lateral roots; and (4) visceral sensory fibres passing in through the dorsal roots only. In the cranial nerves, in addition to these four components, a fifth, the acustico-lateral, can be distinguished in connection with the ear and lateral line organs. No cranial nerve contains all these components, and there is an obvious tendency towards the concentration of the fibres of each component, so as to form a single system with a common center in the medulla.

The composition of the various cranial nerves is as follows. The hypoglossal is composed of somatic motor fibres and passes out as the first member of the first spinal complex. The spinal accessory is made up of visceral motor fibres and passes out with the vagus to innervate the trapezius muscle. The vagus is in the main formed of visceral motor and visceral sensory fibres, together with a few somatic sensory and acustico-lateral fibres. The glossopharyngeal contains only visceral motor and visceral sensory fibres. The auditory is exclusively acustico-lateral. The facial is composed of visceral motor, visceral sensory, and acustico-lateral fibres. The abducens is wholly somatic motor. The trigeminal is visceral motor and somatic sensory. The trochlear and oculomotor are both somatic motor. The optic and olfactory nerves have not as yet been placed in any category.

G. H. P.

Reactions of Entomostraca to Light. — R. M. Yerkes[1] has studied the reactions of two entomostracans, Simocephalus and Cyclops, to differences in light intensity, photopathy. In the experiments the influence of the direction of the light was eliminated and the animals were subjected to light of graduated intensity. Simocephalus moved into regions of greater intensity of light, *i.e.*, was positively photopathic; and the amount of positive movement varied, within certain limits, directly with the intensity of the light. Diffuse daylight caused a greater positive response than direct sunlight. Cyclops proved to be not photopathic. It was also shown that Simocephalus preferred the orange and yellow portion of the spectrum of illuminating gas, but the author concludes that this is a response to inten-

[1] Yerkes, R. M. Reactions of Entomostraca to Stimulation by Light, *Amer. Journ. Physiol.*, vol. iii, pp. 157–182. November, 1899.

sity (photopathic reaction), and is not, as far as is known, a color response (chromopathy).

G. H. P.

Embryology of the Cladoceran Penilia. — The development of Penilia has been studied by M. T. Sudler.[1] The four to six oval eggs of a single laying are usually so placed in the brood sac of the female that their long axes are very nearly parallel to that of the female. The long axis of the egg corresponds to that of the future embryo, and the end of the embryo pointed forward in the brood sac becomes the head. The segmentation of Penilia is total and remains so throughout in strong contrast to that in most other Crustacea. As in Nereis, the first cleavage plane is transverse to the chief axis of the future embryo; the second is in the sagittal plane; and the third is at right angles to both previous planes; the fourth is parallel to the first; and from the fifth on, no clear characterization can be made. Gastrulation takes place in definite relation to the maternal body, *i.e.*, at what may be described as the outer posterior corner of the embryo. The mesoderm originates from either side of the mid-ventral line, and in a way that prevents it from being clearly distinguished from the entoderm for some time. The gastrula mouth closes in the region afterwards occupied by the anus. The order of appearance of the appendages is open to some variation, but is usually as follows: second antenna, first antenna, mandible, first maxilla, second maxilla, thoracic appendages in sequence from the anterior end. Organogeny is briefly dealt with. The reproductive organs cannot be traced to a single cell, as in Moina according to Grobben. On the whole, Penilia gives evidence of being a highly specialized rather than a primitive cladoceran.

G. H. P.

Artificial Parthenogenesis in the Sea Urchin. — Observations on the influence that various dissolved substances have on living muscle and on the fertilized and unfertilized eggs of marine animals have led Loeb[2] to suspect that the reason unfertilized eggs do not develop is not only because of lack of the spermatozoan, but also because of the constitution of the sea water. The addition of magnesium chloride to sea water (5000 $\frac{10}{8}$ n $MgCl_2$ in 5000 cc. of sea

[1] Sudler, M. T. The Development of Penilia schmackeri Richard, *Proc. Boston Soc. Nat. Hist.*, vol. 29, pp. 109–131, 3 plates. October, 1899.

[2] Loeb, J. On the Nature of the Process of Fertilization and the Artificial Production of Normal Larvæ (Plutei) from Unfertilized Eggs of the Sea Urchin, *Amer. Journ. Physiol.*, vol. iii, pp. 135–138. October, 1899.

water) produces a solution which affects unfertilized eggs in the same way as the entrance of a spermatozoan does. Eggs of the sea urchin, when left in this solution for about two hours and then transferred to normal sea water, formed gastrulæ and plutei normal in every respect. In the experiment fewer eggs developed, and their development was slower than under normal conditions. This experiment shows that the unfertilized egg of the sea urchin contains all the essential elements for the production of a perfect pluteus. The reason that sea urchin eggs do not develop parthenogenetically under normal conditions is the constitution of the sea water; this either lacks the presence of a sufficient number of ions necessary for cell division (magnesium, potassium, hydroxyl, or others) or it contains too many unfavorable ions (calcium, sodium, or others). All the spermatozoan needs to carry into the egg for fertilization are ions to supplement one class of substances or counteract the other or both. The spermatozoan may of course also carry in other materials, enzymes, etc. The author concludes this interesting paper with the suggestion that possibly parthenogenesis in mammals is prevented by the ions of the mammalian blood. G. H. P.

Notes. — The concluding number of the *Zoölogical Bulletin* contains the following articles: "The Mesenterial Filaments in Zoanthus sociatus," by J. P. McMurrich; "The Unpaired Ectodermal Structures of the Antennata," by M. M. Enteman; "Synopsis of the Calliphorinæ of the United States," by G. de N. Hough; and "The Accessory Bladders of the Testudinata," by F. W. Pickel. It has been announced that the *Bulletin* will be continued under the name of the *Biological Bulletin.*

A Biological Survey of Mount Shasta, California, has been undertaken by the United States Department of Agriculture, and has been reported upon in *North American Fauna*, No. 16. The general features of the mountain, the forests and forest fires, the life zones, the mammals, birds, and plants of the region are described and the factors influencing distribution are discussed.

BOTANY.

Botanical Papers at the British Association. — Some of the papers presented before the botanical section of the British Association were of unusual importance, and the average merit of the

papers was very high. The presidential address, by Sir George King, was an able review of the history of Indian botany, and an added interest was given by the presence of Sir Joseph Hooker, who proposed the vote of thanks for the section.

The masterly address of the president of the chemical section, Dr. Horace J. Brown, on the assimilation of carbon by the higher plants, was quite as much botanical as chemical in nature, and was a real contribution to this important subject.

The following were some of the papers presented: Professor Marshall-Ward, "Methods in the Culture of Algæ"; Sir W. T. Thistleton-Dyer, "The Influence of the Temperature of Liquid Hydrogen on the Germinating Power of Seeds"; Professor Harold Wager, "Lecture on the Sexuality of Fungi"; Professor F. Darwin, "On the Localization of the Irritability of Geotropic Organs"; Professor D. H. Campbell, "Studies on Araceæ"; Mr. J. C. Willis, "The Morphology and Life-history of Ceylonese Podostemonaceæ"; Professor F. O. Bower, "Remarks on Fern-sporangia and Spores"; Professor A. C. Seward, "The Jurassic Flora of Britain"; Professor E. G. Bertrand, "Sur le structure d'une sigillaire cannelée"; Mr. L. A. Boodle, "The Stem-structure in Schizæaceæ, Gleicheniaceæ, and Hymenophyllaceæ."

Perhaps the most sensational paper presented before the botanical section at Dover was the one by Sir William Thistleton-Dyer, on the power of seeds to resist extremely low temperatures. Carefully selected seeds of several kinds were exposed to the temperature of liquid hydrogen; in one set of experiments they were actually placed in liquid hydrogen for six hours! In spite of the extraordinary ordeal to which they had been subjected, the seeds subsequently germinated almost without exception.

A New Book on Ecology. — Modern text-books are conceived in so many spirits and shaped in so many forms that little except the personal bias of the individual teacher would seem necessary to influence a selection. Some are purely didactic categories of fact, some, mechanical guides for laboratory manipulation, and some are readable essays paving the way for pleasant and profitable hours in the laboratory and the field. Professor Coulter has written one of the happiest books of the latter class, in his *Plant Relations*,[1] which is intended to serve as the eye-opener for a half-year's course in

[1] Coulter, J. M. *Plant Relations.* A first book of botany. New York, D. Appleton & Co. x, 264 pp., 206 ff.

elementary botany, and is to be followed by another volume covering the second half-year. It is a logically conceived book, clearly written and well printed, and illustrated with a series of figures each of which is rightly considered by the author to be worthy of as much study as a page of text. Though written with the expressed purpose of accompanying a laboratory course, in which frequent trips to the woods are advised, it is a book which is likely to be read from cover to cover by any bright boy or girl who picks it up and who knows out-of-door life; and it is a book which can do no harm if so read, for its touch with nature is so close, and verification of the chief elements is made so easy, that only a person of the most superficial tendencies could lay it down without turning at once to the plants about which it speaks. The author is to be congratulated on the happy manner in which he has contributed, as he very modestly styles it, another suggestion as to the method of teaching botany in secondary schools.

T.

The Botanists of Philadelphia.[1] — It is always interesting to know what manner of men one's confrères are, and although the barrier of space is now more nearly overcome than it was a generation ago, it is at best only bridged, and many co-workers in the amiable science know each other even yet only through their publications, or at most fragmentary correspondence. Dr. Harshberger's volume on the men who have made Philadelphia famous in the botanical world gives much information that will be welcomed everywhere, and the numerous portraits which enrich it add not a little to its value. The Bartram coat of arms forms an appropriate frontispiece, and the text is enlivened by many views of historic objects, or the beautiful scenery along the Wissahickon. Six appendixes give information concerning organizations, publications, and other matter more or less pertinent to the biographic details which constitute the greater part of the book, and a general index facilitates the finding of desired items.

T.

An Important Bibliographic Aid.[2] — In a massive volume, forming Additional Series III of the Kew *Bulletin of Miscellaneous Information*, the director of the great English garden has given to

[1] Harshberger, J. N. *The Botanists of Philadelphia and their Work.* Philadelphia, 1899. xii, 457 pp.

[2] *Catalogue of the Library of the Royal Botanic Gardens, Kew.* London, 1899. viii, 790 pp. 8vo. Price seven shillings and sixpence.

the public a catalogue of botanical works such as has never before been issued. The titles are printed on one side of each sheet only, so that additions may readily be entered on the blank pages. Four alphabets are made: "General," "Travels," "Periodicals and Serials," and "Manuscripts." T.

The Flora of New Zealand.[1] — The Education Department of the New Zealand Government has issued a handy volume comprising Ranunculaceæ to Compositæ, and forming part of the *Students' Flora* of that region, on which the late Professor Kirk was at work at the time of his death. From an introductory notice it appears that arrangements are likely to be made for completing the work, and it is said that the figures selected to illustrate the *Flora*, and which are to be printed from an unpublished set of copperplates engraved many years ago for Sir Joseph Banks, will form a separate volume. T.

Botanical Notes. — In Vol. XVI of the *Transactions* of the Kansas Academy of Science Professor Hitchcock publishes the first part of a "List of plants in my Florida herbarium." The list is arranged in the familiar sequence of Bentham and Hooker, and extends from Ranunculaceæ through Bromeliaceæ, and includes twelve hundred and fifty-six numbered species and varieties, for each of which localities are cited.

Part XIII of Mr. Macoun's "Contributions to Canadian Botany," published in *The Ottawa Naturalist* for October, contains notes on the distribution of a considerable number of critical species, among which the blue violets are especially notable.

The *Revue Tunisienne* for October contains the concluding part of a catalogue of the vascular plants of the vicinity of Carthage, which should be of interest to travelers in the Mediterranean. It is curious to observe that only one fern, the true maidenhair, is recorded.

An excellent photograph of the trunk of well-grown American white birch is contained in *Forest Leaves* for October.

An analysis of the frond and stipe anatomy of the ferns of the French Flora, and an analytical key to the genera, based on anatomical characters, are contributed by Parmentier to Vol. IX of the *Annales des Sciences Naturelles, Botanique*.

[1] Kirk, T. *The Students' Flora of New Zealand and the Outlying Islands*. Wellington.

Professor D. H. Otis publishes in the last volume of *Transactions* of the Kansas Academy of Science the results of some experiments on the production of root tubercles on Leguminosæ by inoculating the soil in which they were grown with soil containing the symbiotic fungi which cause the tubercles, showing again that it is practicable to produce such tubercles by inoculation.

One hundred and fifty-four Uredineæ of Kansas are enumerated by Mr. Bartholomew in the last volume of *Transactions* of the Kansas Academy of Science.

Mr. J. B. S. Norton has done a useful piece of work in bringing together for the last volume of *Transactions* of the Kansas Academy of Science a bibliography of literature relating to the effects of wind on plants.

The botanical section of the British Association meeting at Dover was well attended by the British botanists, and the sessions were full of interest. The foreign representation was smaller than has usually been the case. Among those who presented papers or took part in the discussion were the following: Professor E. G. Bertrand, Professor F. O. Bower, Professor D. H. Campbell, Professor F. Darwin, Professor J. B. Farmer, Professor Reynolds Green, Professor M. Hartog, Sir Joseph Hooker, Sir George King, Mr. Arthur Lister, Dr. D. H. Scott, Professor A. C. Seward, Sir W. T. Thistleton-Dyer, Professor Harold Wager, Professor H. Marshall-Ward, and others.

NEWS.

THE American Museum of Natural History of New York has had twenty-three representatives in the field during the past summer.

A monument to Johannes Müller was unveiled at Coblenz, his birthplace, on October 2. The principal address was given by Professor Waldeyer.

Sir John William Dawson died November 19. He was born in Pictou, N. S., Oct. 13, 1820. He was educated there and in Edinburgh. In 1842 he accompanied Lyell in his tour through the United States. In 1855 he became principal of McGill College, at Montreal. His work was largely in geological lines, and his most important contributions related to the geology of the maritime provinces. He published a large number of popular works, mostly upon geology and in opposition to the theory of evolution, of which, among scientific men, he was about the last opponent. He was knighted for his work in 1885.

Professor L. V. Pirsson, of Yale, succeeds the late Professor Marsh as one of the associate editors of the *American Journal of Science.*

The New York Zoölogical Gardens were formally opened November 8. They now contain 850 animals.

Appointments: Rollo K. Beatie, instructor in botany in the Agricultural College of Washington. — Dr. August N. Berlese, professor of natural sciences in the Royal Lyceum at Camerino, Italy. — M. Chatin, professor of histology in the faculty of sciences at the Sorbonne, Paris. — Alessandro Coggi, professor of zoölogy in the University of Siena. — Dr. Edward D. Copeland, assistant professor of botany in the University of West Virginia. — Dr. Carl E. Correns, professor extraordinarius of botany in the University of Tübingen. — Edgar R. Cummings, instructor in geology in Indiana University. — Dr. G. V. N. Dearborn, assistant in physiology in the Harvard Medical School. — Professor J. B. De Torri, of Padua, professor of botany in the University of Camerino. — Dr. Sigmund Fuchs, professor of anatomy and physiology in the Vienna Agricultural Station.

— Dr. K. W. Genthe, instructor in zoölogy in the University of Michigan. — A. W. Gibb, lecturer on geology in the University of Aberdeen. — Dr. L. C. Glenn, professor of geology in North Carolina College. — Dr. S. J. Holmes, instructor in zoölogy in the University of Michigan. — Dr. H. S. Jennings, instructor in zoölogy in the University of Michigan. — Dr. J. B. Johnson, assistant professor of biology in the University of West Virginia at Morgantown. — Dr. A. C. Lane, state geologist of Michigan. — Dr. Henry Sabin Leake, professor of anatomy in Williams College. — Dr. M. von Lenhossek, professor of anatomy in the University at Budapest. — J. J. Lister, fellow of St. John's College, Cambridge. — George W. Martin, of Indianapolis, professor of biology in Vanderbilt University, at Nashville, Tenn. — Dr. Merton L. Miller, associate in anthropology in the University of Chicago. — C. B. Morey, assistant professor of anatomy and physiology in the Ohio State University. — Dr. Pegl, docent in physiology in the University at Graz. — A. C. Seward, fellow of St. John's College, Cambridge. — John L. Sheldon, instructor in biology in the Nebraska State Normal School at Peru. — James Y. Simpson, lecturer on natural science in the Free Church College, Glasgow. — Professor Baldwin Spencer, honorary director of the Natural Museum at Melbourne, Australia. — Dr. Otto Stapf, chief assistant in the Kew Herbarium. — W. H. Twelvetrees, geologist to the government of Tasmania. — Dr. Karl Wenle, assistant in the Ethnological Museum in Leipzig. — Dr. William Morton Wheeler, professor of zoölogy in the University of Texas. — Dr. R. S. Woodworth, assistant in physiology in the Medical School of the University of New York.

Deaths : Mr. Grant Allen, a well-known writer on popular science, in London, October 25, aged 51. — Professor J. B. Carnoy, the well-known cytologist of Louvain, September 6, in Schuls, Engadine. — Professor Erhardt, formerly director of the Natural History Museum at Coburg, Germany, aged 80. — Dr. A. Ernst, director of the National Museum at Carácas, Venezuela. — Pasquale Freda, director of the Agricultural Experiment Station at Rome, July 4. — Charles Howie, bryologist, of St. Andrews, Scotland. — Dr. Walter J. Hoffmann, well known for his researches upon American anthropology, at Reading, Pa., November 8, aged 53. — Dr. F. Kuhla, botanical collector, in Mañaos, Brazil. — Dr. Edouard Petri, professor of geography and anthropology in the University of St. Petersburg, aged 45. — Dr. Karl Russ, ornithologist, at Berlin, September 29, aged 66. — Mr.

W. A. Snow, instructor in entomology in Leland Stanford University, drowned in the harbor of San Francisco, October 10. — James Simpson, curator of the Anatomical Museum of the University of Edinburgh. — Dr. Luther Dana Woodbridge, professor of anatomy in Williams College, November 3, aged 49.

CORRESPONDENCE.

To the Editor American Naturalist:

Sir, — *In re* Mesenchyme *vs.* Mesenchyma permit me to differ for the following reasons:

1. Mesenchyme is shorter and hence better.
2. According to the Standard Dictionary it is the preferred form.
3. It is certainly formed on the analogy of a long list of common scientific names in our language, vertebrate from Vertebrata.
4. It is a more natural English form.
5. Do you use the word "chyme"? May I not claim that "it has good usage"? Why then is mesenchyme a "foreign hybrid"?

Very cordially yours,

Henry B. Ward.

University of Nebraska, Lincoln,
Oct. 12, 1899.

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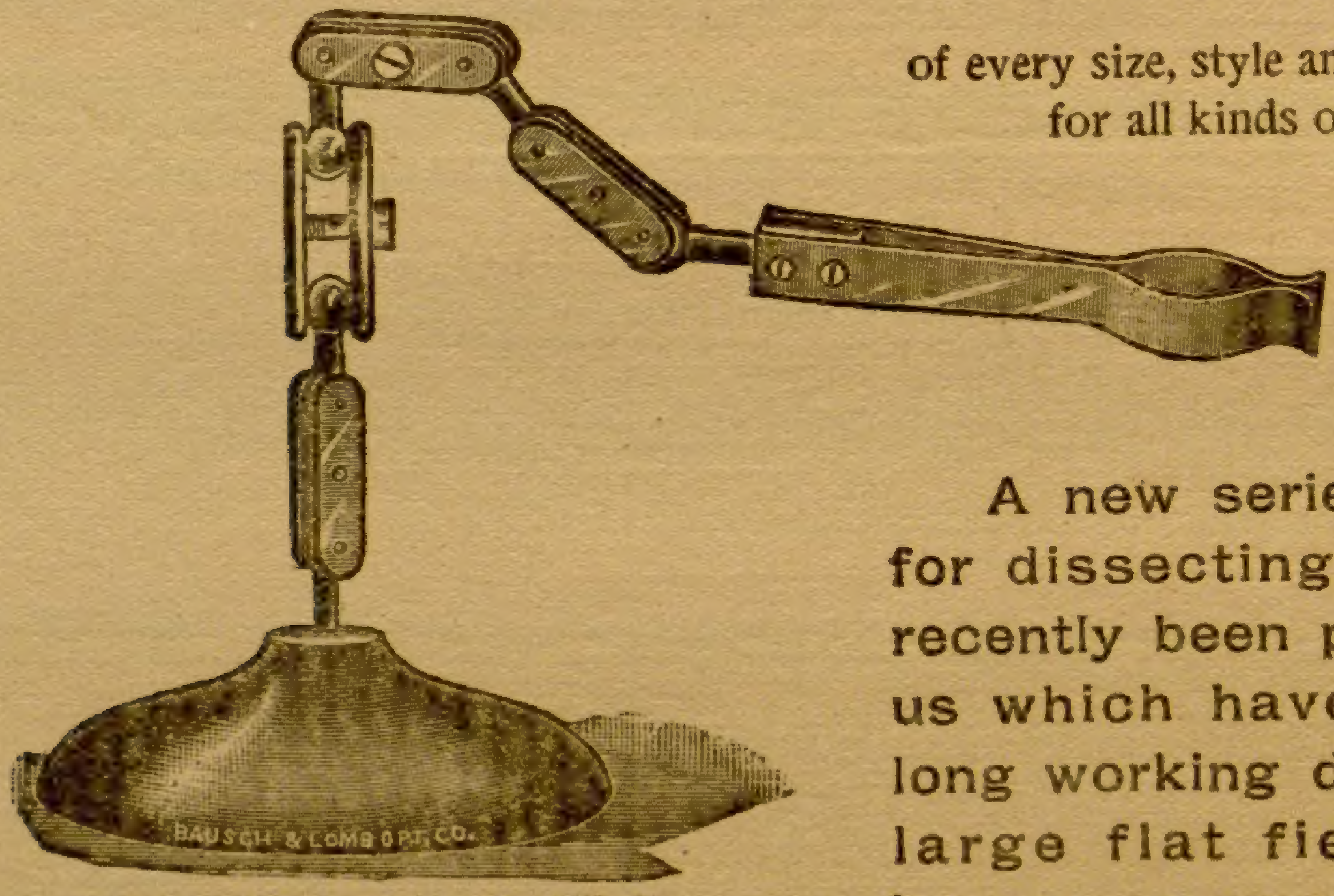

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